Chapter 5.0 Wildlife Resources

Introduction

DWR and Reclamation identified the need to update listed and special-status species information in the 2002 In- Delta Storage Program Planning Study Report on Environmental Evaluations. Species surveys and habitat assessments were conducted in 1988-1989 as part of the Delta Wetlands Project. Since that time, habitat conditions have changed on the project islands and additional listed species, such as the giant garter snake, have been observed on project islands. Additional wildlife surveys and habitat assessments for listed and special-status species were initiated to determine the potential impacts and mitigation required to comply with the federal Endangered Species Act, California Endangered Species Act, National Environmental Policy Act, California Environmental Quality Act, and Migratory Bird Treaty Act, should DWR and Reclamation decide to acquire the Delta Wetlands islands for the In-Delta Storage Project.

This chapter provides the updated species and habitat information for listed and special-status wildlife species and mitigation strategies. The information was collected during 2002 and 2003. Updated information is provided for the following species:

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus)* -FT
Giant garter snake (*Thamnophis gigas*) - FT/ST
Western pond turtle (*Emys marmorata*) - FSC/CSC
Greater sandhill crane (*Grus canadensis tabidia)* - ST
Swainson's hawk (*Buteo swainsoni*) - ST
California black rail (*Laterallus jamaicensis coturniculus)* - ST
Western burrowing owl (*Athene cunicularia hypugaea*) - FSC/CSC
Tricolored blackbird (*Agelaius tricolor*) - FSC/CSC
Loggerhead shrike (*Lanius ludovicianus*) FSC/CSC
Townsend’s big-eared bat (*Corynorhinus townsendii*) FSC/CSC
Pallid bat (*Antrozous pallidus*) - CSC
Small-footed myotis (*Myotis ciliolabrum)* - FSC
Yuma myotis (*Myotis yumanensis)* - FSC
Red bat (*Lasiurus blossevillii*) WBWG - High

FT= Federal Threatened, ST=State Threatened, FSC=Federal Species of Concern, CSC=CA Species of Special Concern, WBWG-High=Western Bat Working Group High Priority

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (VELB), *Desmocerus californicus dimorphus*, has only been found in association with elderberry shrubs. All elderberry shrubs with one or more stems measuring 1.0 inch or greater in diameter at ground level and occur on or adjacent to a proposed project site must be thoroughly searched for beetle exit holes (USFWS 1999a). VELB exit holes are circular or slightly oval and are usually 7-10 millimeters (mm) in diameter (Barr 1991). The VELB is the only known insect to inhabit live elderberry wood or make exit holes of similar size and shape in the Central Valley (Nagano in Barr 1991).

Potential habitat for the VELB on In-Delta Storage Project islands is limited to one large cluster of elderberry shrubs located on the eastern levee of Holland Tract along Old River. The elderberry cluster contains several stems that are 1.0 inch or greater in diameter at ground level. The elderberry shrubs were thoroughly searched for the presence of VELB exit holes during the summer and in the winter. Neither VELB exit holes nor adult beetles were detected in the shrubs during the 2002-2003 field surveys. The elderberry shrubs lack overstory and understory vegetation and are located adjacent to the levee road. The cluster is also isolated from other elderberry shrubs. Therefore, VELB probably do not occur on Holland Tract. No other elderberry shrubs were found on project islands. JSA (1995a) reports that the nearest known VELB population is located along Middle River approximately 17 miles south of Bacon Island.

Giant Garter Snake Habitat Evaluations

A giant garter snake was found on Webb Tract in April 2001. USFWS reported sightings on Medford Island in 1996 and on Horseshoe bend in 1998. These sightings raised the question of whether giant garter snakes could be found on the project islands. For the purposes of the feasibility study, we assumed that giant garter snakes were present and completed a habitat evaluation to determine how much habitat existed on the project islands so we could estimate mitigation needs.

Habitat assessments for the giant garter snake were conducted in 2002 and reflect the site conditions at the time of the assessment. DWR acknowledges that the project islands are managed for agriculture and that habitat values and quantities for the giant garter snake are dynamic. Habitat conditions can change from year-to-year depending on the maintenance activities and the specific farming practices that are undertaken. DWR will conduct a survey to determine if giant garter snakes are present or absent on the reservoir islands in 2003 and in 2004. After the results of the 2003 surveys are completed, DWR will evaluate the results and determine, with the input from resource agencies, the objectives for the 2004 surveys. The habitat evaluations of the project islands presented in this section will be used to guide the presence/absence surveys and to determine the potential impacts and mitigation requirements assuming for planning purposes that giant garter snakes are present on the project islands.

Methods

Qualification of Habitat

Between August 31 and September 23, 2002, the four project islands (Bacon Island, Bouldin Island, Holland Tract, and Webb Tract) were visited by a DWR biologist and Eric Hansen, Consulting Herpetologist, for the purpose of evaluating the quality of potential giant garter snake (*Thamnophis gigas*) habitat present. Only the area owned by Delta Wetlands was evaluated, so most of the southwestern corner of Holland Tract was excluded from this task. Most of the primary access roads and some of the secondary roads were driven to get adequate coverage of the islands. Because complete coverage of the islands was not practicable, aerial photographs were used to determine the best areas to visit to take pictures of representative habitats. The locations of the pictures were recorded using a hand-held GPS unit, and habitat features were described into a micro cassette recorder. An evaluation method developed by Mr. Hansen was utilized, in which factors that determine the habitat's suitability for giant garter snake use are scored and zones of contiguous habitat are then categorized (Figure 5-1) (Hansen 2002). These factors are based on well-accepted and documented life history requirements of giant garter snakes. A thorough discussion of giant garter snake life history and ecology can be found in the U.S. Fish and Wildlife Service Draft Recovery Plan for the Giant Garter Snake (USFWS 1999b), Natural History of the Giant Garter Snake (Brode 1988), and Review of the Status of the Giant Garter Snake (Hansen 1988).

With georectified digital aerial photographs taken on April 23, 2001 as a template, all areas that appeared to hold water during at least some part of the year, as well as uncultivated upland areas, were digitized using ArcGIS 8.2. Irrigation ditches dominated the aquatic habitat on the islands, while blow-out ponds, borrow pits and exterior levee habitat, evaluated by Mr. Hansen during winter and spring 2002 (Hansen 2002), also contributed to the total amount of habitat evaluated and quantified. An evaluation was completed for each habitat feature (e.g., irrigation ditch, blow-out pond). When the value of a factor changed, a new evaluation was conducted, so most habitat features are characterized by multiple evaluations. This happened most often when a section of the irrigation ditch came within 200 feet of uncultivated upland. This triggered the inclusion of additional factors for scoring and frequently resulted in a different habitat quality value for that section of ditch (see evaluation method below). The 200-foot buffer is based on the definitions of “Giant Garter Snake Habitat” and “Disturbance Area” in the Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California (USFWS 1997b). For the purposes of that programmatic opinion, the U.S. Fish and Wildlife Service incorporated 200 feet of upland on each bank side of the linear aquatic habitat in its description of a giant garter snake habitat unit and its assessment of disturbance area. A complete description of the scoring technique utilized for these evaluations follows:

1. *Still or slow-flowing water over silt substrate* – This factor received a +1 if bank habitat adjacent to water was composed of soil, silt, or mud, and/or water flows no greater than 3 mph. Water will often look dark and murky like that seen in marshes, sloughs, or irrigation canals. A silt substrate also provides a muddy bottom into which giant garter snakes can bury themselves to escape predation. This factor received a 0 if no water was present at the time of the evaluation or if it the water and substrate were better characterized by Factor 2.
2. *Flowing water over sand, gravel, rock or cement substrate* – This factor received a -1 if bank habitat adjacent to water was composed of any of these substrates, and/or the water was flowing greater than 3 mph. Under these conditions, water will often appear clear, and a muddy bottom will not exist. Giant garter snakes, therefore, lack the protection provided by slow-moving water over a silt substrate, and the Recovery Plan states that “Giant garter snakes are absent from large rivers and from wetlands with sand, gravel, or rock substrates” (USFWS 1999b). This factor received a 0 if no water was present at the time of the evaluation or if the water flow and substrate were better characterized by Factor 1.
3. *Water available* – These categories are additive because the more persistent water is, the more consistent it’s availability is for use by giant garter snakes.
   a) *Winter run-off only or sporadic availability* – This factor received a +1 for all aquatic habitat on the islands because they all received at least winter run-off, and water was only sporadically available for most habitat due to the crop types farmed.

b) *April through October only (irrigation)* – This factor received a +1 if water was available more than sporadically during the active season. At least some persistent water or sign of persistent water (e.g., green emergent marsh vegetation, moist soil) must have been present at the time of the evaluation for this factor to receive a positive score. This factor received a 0 if no water was present at the time of the evaluation and there did not appear to be a consistent water supply throughout the active season.

c) *All year* – This factor received a +1 if water appeared to be available during the entire year (e.g., blow-out ponds, main irrigation canals). This factor received a 0 if water did not appear to persist throughout the entire year.

4. *Banks are sunny* – This factor was given a score between +1 and +3 depending on the amount of direct sunlight the bank habitat adjacent to the water received. This score was influenced most strongly by the type of bank vegetation present and reflected the percent area available for basking. For example, banks dominated by Bermuda grass (*Cynodon dactylon*) and/or Himalayan blackberry (*Rubus discolor*) facilitate basking by providing exposed, stable platforms. Banks dominated by Johnson grass (*Sorghum halepense*) and/or barnyard grass (*Echinochloa crus-galli*) do not. This factor was given a score of 0 if no direct sunlight hit the habitat feature.
5. *Banks are shaded by overstory vegetation* – This factor was given a score between -3 and -1 depending on the amount of bank habitat adjacent to the water which received shade. Similar to Factor 4, this score was influenced strongly by the type of bank vegetation present and its ability to produce shade and preclude basking. Woody, overstory vegetation such as mature willows (*Salix* spp.) and cottonwoods (*Populus* spp.) impede a snake's ability to bask. Unlike mature willows, immature willows provide low branches facilitating aquatic escape and do not obscure sun. This factor was given a score of 0 if the banks received no shade.
6. 6. *Aquatic or emergent vegetation present* – This factor was given a score between +1 and +3 depending on the percent cover of emergent or aquatic vegetation (e.g., cattail (*Typha* spp.), bulrush (*Scirpus* spp.), water primrose (*Ludwigia peploides)*, water hyacinth (*Eichhornia crassipes*)) present within the bed of ditch and on the margins of the bank. Emergent aquatic vegetation can provide basking habitat, foraging opportunities, and cover from predators. This factor was given a score of 0 if aquatic or emergent vegetation was absent from the bed and banks.
7. Terrestrial vegetation present

a) *On banks* – This factor was given a score between +1 and +3 depending on the percent cover of bank vegetation. The greater the amount of terrestrial vegetation present, the more cover from predators giant garter snakes gain. This factor received a score of 0 if there was no vegetation on the banks.

b) *On adjacent uplands* – This factor was given a score between +1 and +3 depending on the percent cover of uncultivated upland vegetation within 200 feet of the water. This factor was given a 0 if there were no uncultivated uplands within 200 feet of the water or if the uplands within this area possessed no vegetation.

8. Subterranean retreats present

   a) *In banks* – This factor received a score of +1 if bank habitat possessed burrows, holes, or cracks either in the soil or under debris. These burrows, holes, and cracks provide subterranean retreats for summer aestivation, overwintering, and cover from predators. This factor received a score of 0 if bank habitat lacked these features.

   b) *In adjacent uplands* – This factor received a score of +1 if uplands within 200 feet of the water possessed burrows, holes, or cracks either in the soil or under debris. This factor received a score of 0 if the uplands within 200 feet of the water lacked these features.

9. *Prey fish present* – This factor received a score of +1 if small aquatic prey fish (e.g., mosquitofish, blackfish) were observed or could be assumed present within the aquatic habitat. Prey fish were assumed to be present wherever it appeared water persisted beyond only sporadic availability. This factor received a score of 0 if small aquatic prey fish were absent or could be assumed absent, which was directly linked with presence of water.

10. *Introduced gamefish present* – This factor received a score of -1 if introduced gamefish (e.g., bass, catfish) were observed or could be assumed present within the aquatic habitat. Predatory gamefish such as these are often cited as a factor contributing to the apparent lack of giant garter snakes in large bodies of water (Brode 1988). Introduced gamefish were assumed to be present wherever it appeared that water persisted throughout the entire year and emergent aquatic vegetation was sparse (e.g., blow-out ponds, some main canals). This factor received a score of 0 if introduced gamefish were absent or could be assumed absent due to water persistence.

11. *Prey amphibians present* – This factor received a score of +1 if amphibians (e.g., bullfrog, treefrog) were observed or could be assumed present within or near the aquatic habitat. Giant garter snakes prey on both larval and adult frogs. When not directly observed, frogs were assumed to be present whenever the habitat feature was not completely dry at the time of the survey. This factor received a score of 0 if amphibians were absent or could be assumed absent due to lack of any water or moisture.

12. *Site is subject to severe seasonal or tidal flooding* – This factor received a score of -1 if the habitat feature was scheduled to be flooded over its banks during winter 2002-03. Flood waters can displace and even kill overwintering snakes. This factor received a 0 if the habitat feature was not scheduled to be flooded this winter or if it would not overtop its banks. The latter was assumed when a ditch was adjacent to a field scheduled for flooding and it was adjacent to a levee or access road with subterranean retreats, which would not be flooded.
13. *Adjacent land use*

    a) *Rice* – In terms of agricultural land, ricefields best resemble historic marsh habitat and can provide suitable foraging and basking habitat as well as shelter for giant garter snakes. None of the islands was farmed with rice, so this factor always received a score of 0 for these evaluations.

    b) *Upland* – This factor received a score of +1 if uncultivated uplands occurred within 200 feet of the habitat feature. Typically, these uplands provide basking habitat, possess subterranean retreats, and undergo less disturbance than other types of adjacent land use. Pasture land on Holland Tract was scored as uncultivated upland. This factor received a score of 0 if no uncultivated uplands occurred within 200 feet of the habitat feature.

    c) *Row Crop* – This factor received a score of -1 if row crops were grown within 200 feet of the habitat feature. In general, row crops are the product of intensive agricultural practices which disturb the land to the point that it does not provide any suitable habitat for giant garter snakes, and the farming practices themselves may injure or kill snakes. All of the islands, with the exception of Holland Tract, were intensively farmed in row crops. This factor received a score of 0 if row crops were not grown within 200 feet of the habitat feature.

    d) *Urban* – Run-off from urban areas can introduce pollutants into aquatic habitat, and the introduction and subsidization of predators such as cats and raccoons often accompanies human encroachment (Hansen 1988). None of the islands have urban development, so this factor always received a score of 0.
14. *Disturbance due to human recreational or maintenance activities* – This factor received a score of -1 if the habitat was subjected to prolonged or regular intense disturbance by human recreational or maintenance activities. Well-maintained and often-traveled access roads were included if they were directly adjacent to the habitat being evaluated because frequent traffic increases the risk of road mortality and regular disturbance can induce snakes to leave an area. This factor received a score of 0 if prolonged or regular disturbance by human recreational or maintenance activities did not occur. Activities such as periodic farm

maintenance constitute only a temporary and recoverable disturbance and were therefore scored as a 0.

15. *Connectivity to known populations of GGS* – Because the distribution of giant garter snakes in the Delta is largely unknown, this factor was not scored in these evaluations. All the Delta Wetlands Islands are hydrologically connected to historical and/or current giant garter snake occurrences and therefore could potentially support this species.

Total scores could have ranged between -8 and +22, but the actual range of values for the habitat features evaluated on the project islands was +3 to +19. Based on field observations in September 2002, the aerial photographs from April 2001, an understanding of the life history of giant garter snakes, and comparison of the total scores for each habitat feature, three levels of habitat quality were classified: low, moderate, and high. Generally, quality is determined by the habitat's ability to meet giant garter snake life history requirements. Specifically, quality is based on the presence and relative proportion of habitat factors necessary to support giant garter snakes and the amount of time that these factors are available during the April through October active season of the snake.

In general, high quality habitat possesses 1) sufficient water during the active summer season to supply cover and food such as small fish and amphibians; 2) emergent, herbaceous aquatic vegetation accompanied by vegetated banks to provide basking and foraging habitat; 3) bankside burrows, holes and crevices to provide short-term aestivation sites; 4) high ground or upland habitat above the annual high water mark to provide cover and refugia from floodwaters during the dormant winter season. Typically, habitat quality was classified as high when possessing all of these features for the entire active season, thereby providing stable habitat capable of supporting permanent populations of giant garter snakes. In general, moderate quality habitat possesses appropriate factors either temporarily or in marginal proportions, thereby providing giant garter snakes with only marginal or transient habitat less capable of sustaining permanent populations of snakes. In general, low quality habitat is incapable of supporting either permanent or temporary populations of giant garter snakes but is capable of providing transit corridors between more suitable habitats.

The divisions between the three habitat quality classifications were formed by comparing overall scoring results of the completed evaluations with known giant garter snake life history requirements. The point values for low quality habitat range between 3 and 7. The point values for moderate quality habitat range between 8 and 11. The point values for high quality habitat range between 12 and 19. The three levels of quality are represented by unique colors on the maps: blue = low, yellow = moderate, and red = high. Uncultivated, non-pasture uplands are mapped in green, but uplands were not evaluated for their quality.

Quantification of Habitat

From descriptions of ditch width transcribed from the micro cassette recordings and using a measurement tool in ArcGIS to take various measurements of ditch widths from the digital aerial photographs, the linear aquatic habitat on the interior of the island was divided into four general categories of width: 4, 12, 20, and 32 meters. Because ArcGIS was used to project the evaluations onto a digital aerial photograph, the length of each unique evaluation could be easily calculated. After assigning a width to each evaluation, area was calculated by multiplying length and width. The exceptions to this method of calculating area occurred when quantifying the levee habitat between the water channel and the toe ditch. Mr. Hansen's evaluations of the channel-side habitat were projected onto the digital aerial photographs, and the area for these linear segments was calculated from the edge of the aquatic vegetation, when present, to the crown of the levee. Likewise, the area of the levee toe ditch habitat was calculated from the edge of the ditch to the crown of the levee.

For non-linear aquatic habitat (e.g., blow-out ponds, borrow pits), the area that appeared to pond water, based on the aerial photographs from April 2001, was digitized, and a 200 foot buffer was created around it. As mentioned above, the 200-foot buffer was implemented based on definitions of giant garter snake habitat and disturbance area found within the U.S. Fish and Wildlife Service's Programmatic Consultation (USFWS 1997b). Therefore, the total area of non-linear aquatic habitat calculated for each island includes that 200-foot buffer of uplands, when it existed.

The boundaries of uncultivated uplands that were not already included in the linear and non-linear aquatic habitat quantifications were digitized using aerial photographs and descriptions of conditions observed in the field. Holland Tract is currently used as rangeland, and therefore the entire island could be considered upland. However, livestock grazing often results in the loss of bank and upland vegetation, as well as loss of upland refugia due to ground compaction. For this reason, only areas where livestock were excluded are included in the quantification of upland habitat because these are areas where subterranean retreats and dense vegetative cover potentially exist. These areas are either fenced or possess vegetation that is too dense to permit livestock access. Uplands included in the quantification of potential habitat were either located within 200 feet of aquatic habitat or were contiguous with uplands that were located within 200 feet of aquatic habitat.

Results And Discussion

Bacon Island

Bacon Island had a total of 734 acres (297 ha) of potential giant garter snake habitat in 2002 (Figure 5-2). Most of the linear aquatic habitat consisted of narrow trench ditches between fields of corn, sunflower, and harvested potato. These low quality ditches are likely only useful as transit corridors or provide only temporary habitat. One large north-south running canal bisects the island, and a few wider ditches running roughly east-west have perennial water. These ditches provided the only high quality habitat on the island, possessing the habitat features required to sustain a population of giant garter snakes. The toe ditches scored as moderate quality based on their proximity to uplands suitable for aestivation and overwintering. A large proportion of the area of moderate quality habitat can be attributed to these toe ditches. Sections of the exterior levee were heavily rip-rapped and offered very little suitable habitat, while others were characterized by freshwater emergent marsh and possessed better potential to support the species. Bacon Island had only one small borrow pit that appeared to hold winter run-off water during the spring, which would provide good, but temporary, habitat. Uplands included a large fallow field and a riparian area on the interior. Bacon Island is surrounded by many high quality in-channel islands, as well as the Western Pacific railroad tracks, and is located only 2.5 km (1.55 miles) away from a California Natural Diversity Database record of a giant garter snake skin found in 1996 on the southwest end of Medford Island (CNDDB 2002). While these additional factors did not contribute to the classification of habitat quality because adjacent habitat and connectivity to known populations of giant garter snakes were not scored in these evaluations, they warrant mention because they indirectly improve Bacon Island's potential to support giant garter snakes.

Table 5-1. 2002 Bacon Island Potential Giant Garter Snake Habitat

		Acres	Hectares
Linear Aquatic Habitat			
	High Quality	85	34
	Moderate Quality	461	186
	Low Quality	132	54
Non-linear Aquatic Habitat			
	High Quality	0	0
	Moderate Quality	3	1
	Low Quality	0	0
Uplands		53	22
TOTAL		734	297

Bouldin Island

Bouldin Island had a total of 957 acres (388 ha) of potential giant garter snake habitat in 2002 (Figure 5-3). Most of the linear aquatic habitat consisted of narrow trench ditches between fields of corn and grain providing only transit corridors and/or temporary habitat. A larger canal meandered through part of the island, and a few wider canals held water throughout the year. These provided the best overall quality habitat on the island due to consistent water availability and possession of decent aquatic and terrestrial vegetation, subterranean retreats, and prey. Like Bacon, Bouldin Island's toe ditches were typically moderate in quality and contributed greatly to the overall area of this level of habitat quality. The exterior levee habitat was also similar to Bacon's. On the interior, Bouldin Island had a number of areas that appeared to be old borrow pits that have since developed into marsh and riparian areas with water available at least part of the year. In some cases water persisted throughout the active season. Many of these areas contributed to the area of high quality. Uplands consisted of two small areas that appear to stay fallow and may provide suitable basking and/or aestivation sites due to their proximity to aquatic habitat. Bouldin Island is surrounded by a few in-channel islands of moderate and high quality, but not to the extent Bacon is. Bouldin Island is located approximately 5.7 km (3.54 miles) from Caldoni Marsh (CNDDB 2002), one of the thirteen populations of giant garter snakes recognized in the Recovery Plan (USFWS 1999b).

Table 5-2. 2002 Bouldin Island Potential Giant Garter Snake Habitat

		Acres	Hectares
Linear Aquatic Habitat			
	High Quality	117	47
	Moderate Quality	669	271
	Low Quality	132	53
Non-linear Aquatic Habitat			
	High Quality	26	11
	Moderate Quality	9	4
	Low Quality	0	0
Uplands		4	2
TOTAL		957	388

Holland Tract

Holland Tract had a total of 581 acres (235 ha) of potential giant garter snake habitat in 2002 (Figure 5-4). Because Holland Tract was used as rangeland, it had relatively few narrow trench ditches and consequently relatively less low quality habitat. In addition, because these narrow ditches were not directly adjacent to actively farmed land, they received higher overall scores than their counterparts on the other islands that were intensively farmed. However, they still likely only provided temporary and/or transit corridor habitat. Like Bacon, a main north-south running canal bisected the island, and a few wide east-west running canals apparently held water perennially. While there was evidence that livestock and their waste enter these ditches, overall they possessed those habitat features consistent with high quality (e.g., prey, aquatic and terrestrial vegetation, subterranean retreats, and naturally vegetated uplands). The exterior levee habitat on Holland Tract ranges from wide belts of freshwater emergent marsh to rip-rap and is classified as high, moderate, and low in certain sections. While the toe ditches don’t differ much from those on the other islands, they are not directly adjacent to intensive farming, and therefore possess slightly better quality. For this reason, some of the levee area associated with the toe ditches was classified as high as well as moderate. There is one large blow-out pond and a few borrow pits and low areas, which appear to pond water at least temporarily. While the large blow-out pond contains introduced predatory fish and has a sandy bottom which prevents snakes from burrowing in the mud to escape predators, it still possesses enough positive features to support giant garter snakes and qualify as high quality. The other areas could provide temporary habitat because they likely support populations of amphibian prey until they draw down. As mentioned above, the upland area calculated only includes those areas where livestock were excluded. The remainder of the uplands used by livestock totals approximately 3680 acres (1489 ha), but this area is less suitable for giant garter snake use because livestock grazing often results in the loss of bank and upland vegetation, as well as loss of upland refugia due to ground compaction. Holland Tract is surrounded by many high quality in-channel islands and is located nearly equidistant between two recent giant garter snake records: the abovementioned skin found on the southwest end Medford Island in 1996 and a snake found on the southwest end of Webb Tract in 2002 (5.9 km (3.67 miles) and 5.6 km (3.48 miles), respectively) (CNDDB 2002).

Table 5-3. 2002 Holland Tract Potential Giant Garter Snake Habitat

		Acres	Hectares
Linear Aquatic Habitat			
	High Quality	181	73
	Moderate Quality	286	116
	Low Quality	8	3
Non-linear Aquatic Habitat			
	High Quality	45	18
	Moderate Quality	37	15
	Low Quality	0	0
Uplands		24	10
TOTAL		581	235

Webb Tract

Webb Tract had a total of 949 acres (384 ha) of potential giant garter snake habitat in 2002 (Figure 5-5). While a fair amount of the linear aquatic habitat consisted of low quality, narrow trench ditches that likely provided only transit corridor and/or temporary habitat, Webb Tract had relatively more wide canals with persistent water than the other islands. The main north-south and east-west canals possessed all the factors necessary to support a permanent population of giant garter snakes (e.g., permanent water, aquatic and terrestrial vegetation, prey, subterranean retreats, as well as a wide upland shelf between the canal and agricultural activity). Like the other islands, the exterior levee habitat ranged from heavy rip-rap to emergent marsh, which qualified as low and moderate habitat. Parts of the toe ditch appeared to be wider with more persistent water than other parts. These more closely resembled the main north-south and east-west canals, although they were narrower, and were classified as high quality habitat. The remainder of the toe ditch was similar to those on other islands and probably only provided temporary or marginal habitat value. Webb Tract has two large blow-out ponds and a couple borrow pits or depressions that appear to pond water. While the blow-out ponds contain predatory fish and a sandy bottom to some extent, they also possess nice patches of emergent marsh, expansive uplands, and prey. All the borrow pits were dry in September, so they would only provide temporary habitat. Uplands on Webb Tract were primarily characterized by riparian vegetation surrounding the blow-out ponds; however, there were some patches of fallow land that could provide basking, aestivation, and overwintering habitat. Webb Tract is surrounded by some high and moderate quality in-channel islands, as well as some wide, fast-flowing channels. A giant garter snake was found on Webb Tract in April 2002 near the ferry dock, and the next closest CNDDB record is 5.2 km (3.23 miles) away between Highway 160 and Horseshoe Bend where a snake was observed in 1998 (CNDDB, 2002).

Table 5-4. 2002 Webb Tract Potential Giant Garter Snake Habitat

	Acres	Hectares
Linear Aquatic Habitat		
High Quality	168	68
Moderate Quality	452	183
Low Quality	97	39
Non-linear Aquatic Habitat		
High Quality	55	22
Moderate Quality	92	37
Low Quality	0	0
Uplands	85	34
TOTAL	949	384

Delta Wetlands Islands Total

The total amount of potential giant garter snake habitat for all four islands visited in 2002 is 3221 acres (1304 ha). Of that, approximately 677 acres (273 ha) is high quality habitat, 2009 acres (813 ha) is moderate quality habitat, 369 acres (149 ha) is low quality habitat, and 166 acres (68 ha) is upland. When looking at Figures 5-2 to 5-5, there appears to be a substantially higher proportion of low quality linear aquatic habitat (except on Holland Tract), but in reality the total area of low quality habitat is much smaller than that for high or moderate quality linear aquatic habitat (see tables above). Nearly all of the low quality ditches were narrow, so while length of low quality habitat greatly exceeded that of moderate or high quality, overall area did not. In addition, none of the toe ditch-to-levee crown nor ponds and borrow pits ranked any lower than moderate quality. To reiterate, areas classified as high quality habitat normally provide stable habitat capable of supporting permanent populations of giant garter snakes. Typically, areas classified as moderate quality habitat would provide giant garter snakes with only marginal or transient habitat less capable of sustaining permanent populations. And generally, areas classified as low quality are incapable of supporting either permanent or temporary populations of giant garter snakes but can provide transit corridors between more suitable habitats.

On February 5, 2003, Eric Hansen and staff from USFWS, DFG, DWR, Reclamation and CH2M HILL met to discuss the giant garter snake (GGS) habitat evaluations and appropriate mitigation for loss of potential habitat on the reservoir islands. At this meeting USFWS decided that all habitat that ranked as low quality was so poor that mitigation would not be required for its loss; however, all moderate and high quality habitat would require 3:1 mitigation. The USFWS also maintained that mitigation would not be required for suitable upland habitat that was greater than 200 feet from moderate or high quality aquatic habitat. Based on this direction from the USFWS, DWR staff recalculated the amount of potential GGS habitat that would be lost from the reservoir islands. The resulting areas of potential GGS habitat are 458 acres on Bacon Island and 657 acres on Webb Tract. Therefore, the total area requiring mitigation is 1,115 acres, which at 3:1 amounts to 3,345 acres of suitable GGS habitat that must be preserved or created on the habitat islands.

Figure 5-1. Habitat Evaluation And Scoring Form For Geographic Information Systems (GIS)

Giant Garter Snake (*Thamnophis gigas*)

Site Name:______________________________ Site ID:________________

GeneralCharacteristic:____

USGS 7.5' Topo Quad_________________ Township_______ Range________

Surveyor/Affiliation: ______________________________ Date(s): ____________

Scores: 0=absent/none 1=present/low (0-25%) 2=moderate (25-75%) 3=high (75-100%)

Factor (* indicates presence/absence only)	State	Score
1. Still or slow-flowing water over silt substrate	**( ) ***	**( ) +**
2. Flowing water over sand, gravel, rock or cement substrate	**( ) ***	**( ) --**
3. Water available (categories are additive):		
a) Winter only (runoff) or sporadic availability	**( ) ***	**( ) +**
b) April through October only (irrigation)	**( ) ***	**( ) +**
c) All year	**( ) ***	**( ) +**
4. Banks are sunny	**( )**	**( ) +**
5. Banks shaded by overstory vegetation	**( )**	**( ) --**
6. Aquatic or emergent vegetation present	**( )**	**( ) +**
7. Terrestrial vegetation present		
a) On banks	**( )**	**( ) +**
b) On adjacent uplands	**( )**	**( ) +**
8. Subterranean retreats present		
a) In banks	**( ) ***	**( ) +**
b) In adjacent uplands	**( ) ***	**( ) +**
9. Prey fish present	**( ) ***	**( ) +**
10. Introduced gamefish present	**( ) ***	**( ) --**
11. Prey amphibians present	**( ) ***	**( ) +**
12. Site subject to severe seasonal or tidal flooding	**( ) ***	**( ) --**
13. Adjacent land use		
a) Rice	**( ) ***	**( ) +**
b) Upland	**( ) ***	**( ) +**
c) Row Crop	**( ) ***	**( ) --**
d) Urban	**( ) ***	**( ) --**
14. Disturbance due to human recreational or maintenance activities	**( ) ***	**( ) --**
15. Connectivity to known populations of GGS	**( ) ***	**( ) +**

Total: [ ]

For additional maps or notes use back of page

Modified from U.S. Fish and Wildlife Service. 1999. Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). Appendix D: Page 157. Modified for scoring by Eric. C Hansen: 2001

Figure 5-2. Potential Giant Garter Snake Habitat – Bacon Island, 2002

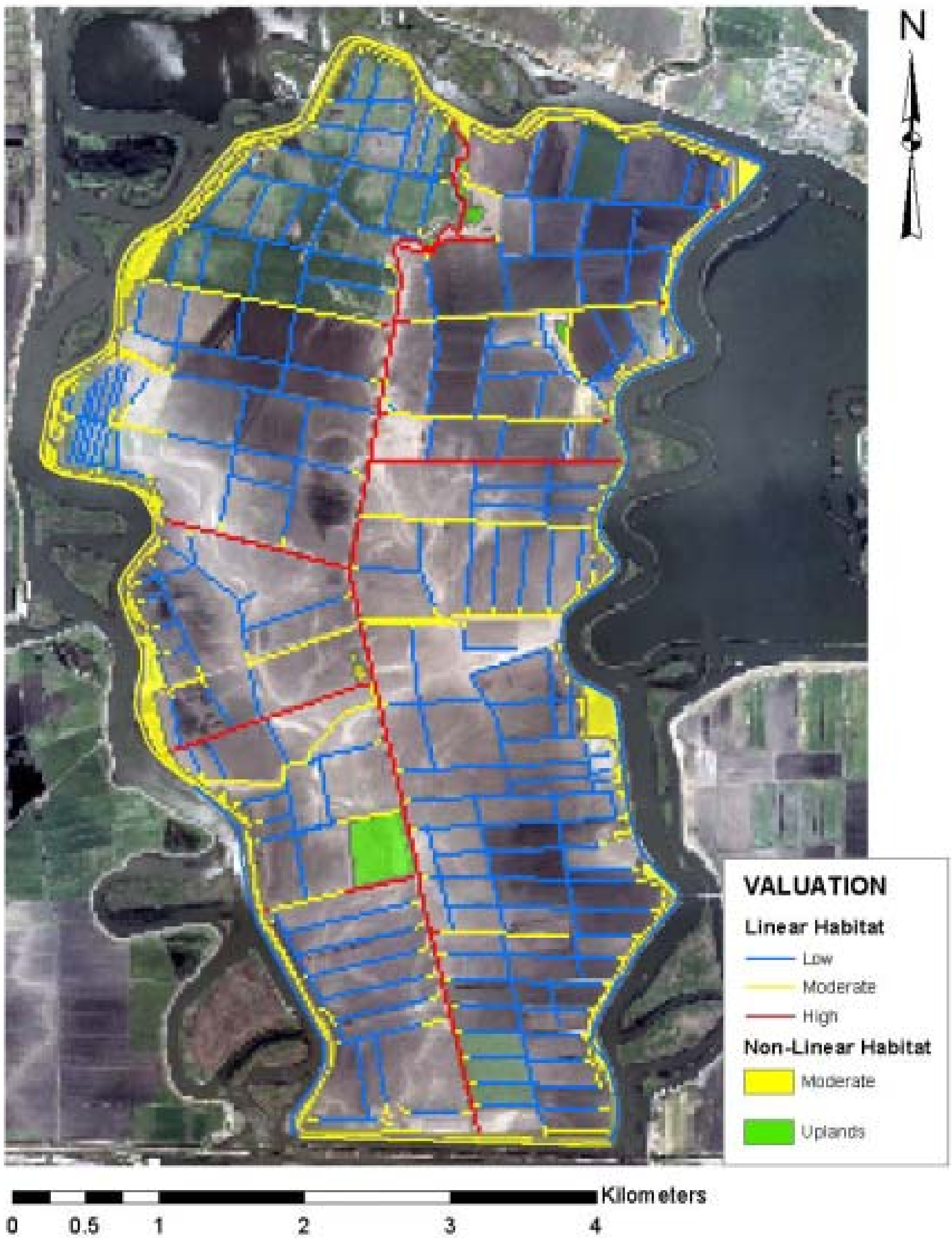


Figure 5-3. Potential Giant Garter Snake Habitat – Bouldin Island, 2002

Figure 5-4. Potential Giant Garter Snake Habitat – Holland Tract, 2002

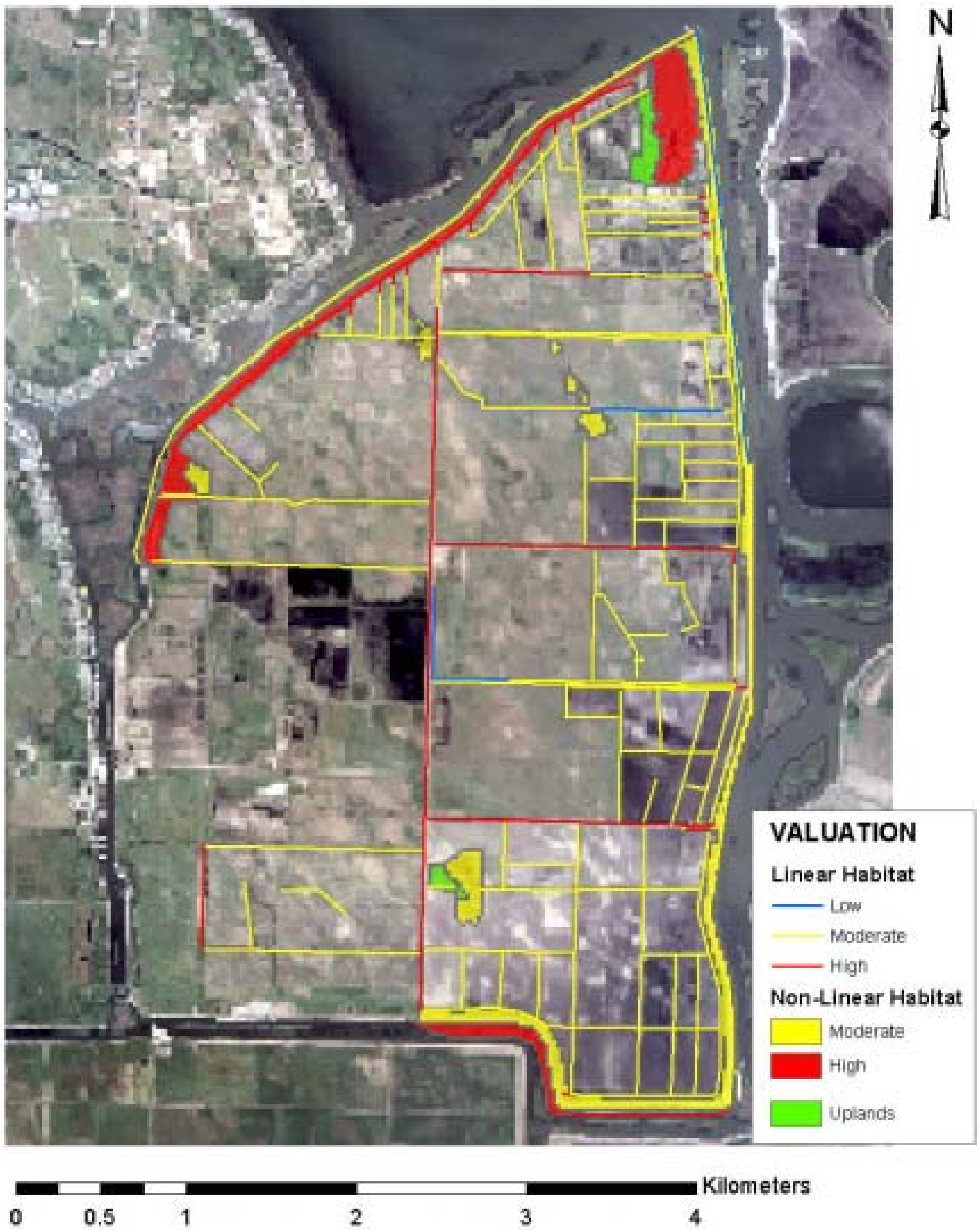


Figure 5-5. Potential Giant Garter Snake Habitat – Webb Tract, 2002

Western Pond Turtle

The western pond turtle (*Emys marmorata*) belongs to the box and water turtle family, Emydidae, and is the only native freshwater turtle west of the Sierra Nevada-Cascade divide (Storer 1930). Western pond turtles are small to medium sized turtles (straight-line carapace length 110-210 mm in adults) with a low to moderately domed shell that is olive, dark brown, gray, or black and lacks prominent markings. Western pond turtles are habitat generalists, historically occurring in a wide variety of fresh and brackish, permanent and intermittent aquatic habitats (Holland 1991). They can be found living in sloughs, streams (permanent and intermittent), large rivers, lakes, ponds, vernal pools, and even irrigation ditches, but they prefer aquatic habitat with still or slow-flowing water, adequate vegetative cover, and exposed basking sites (Holland 1991; Ernst and others 1994). Hatchlings and small juveniles require specialized microhabitats, characterized by shallow water (less than 30 cm deep), with emergent vegetation usually rushes (*Juncus* sp.) or sedges (*Carex* sp.) but often cattails (*Typha* sp.) or bulrushes (*Scirpus* sp.) (Holland 1991).

There is a paucity of information on western pond turtle nest site characteristics, and relatively little is understood about their reproductive ecology. Females typically oviposit from May through July (Holland 1991). Storer (1930) reported that along the courses of the large rivers, females typically deposited their eggs in the sandy banks, and Holland (1991) noted that females tended to place their nests on grassy, unshaded south-facing slopes. Holte (1998) described western pond turtle nest sites as typified by low slopes; southern aspects; dense low-growing forbes and grasses with no overstory cover; and dry, compact soil during nesting and overwintering periods with short periods of inundation during winter. Eggs usually hatch in late summer, and hatchlings often overwinter in the nest, emerging the following spring (Holland 1991).

While some western pond turtles spend the winter in aquatic habitats, most overwinter terrestrially. Holland (1991) claimed that overwintering is one of the least understood aspects of the natural history of the western pond turtle. Davis (1998) reported that along a central coast California stream, western pond turtles buried themselves in leaf litter or soil primarily in riparian forests with a dense native understory. Rathbun and others (2002) also found that most western pond turtles overwintering on land preferred dense riparian thickets dominated by willows (*Salix* sp.) with a thick understory of blackberry (*Rubus* sp.), poison oak (*Toxicodendron diversilobum*), and Cape ivy (*Delaria odorata*).

The western pond turtle is listed as a Federal Species of Concern by the U.S. Fish and Wildlife Service and a Species of Special Concern by the California Department of Fish and Game (DFG 2002). Major factors contributing to the decline of this species are most likely related to the adverse effects of conversion of aquatic, wetland, riparian, and adjacent upland habitats to other land uses such as agriculture, urban, and industrial, or as a result of ongoing land-use practices (CALFED 2000). The aquatic habitats that persist are largely fragmented, and associated upland habitats are typically unavailable; those remaining are often isolated in narrow bands along rivers, streams, and canals with small levees (CALFED 2000). While finding western pond turtles in the Sacramento-San Joaquin Delta is still relatively easy, it has been reported that most individuals seen are large, old turtles and that observations of hatchlings and small turtles are increasingly rare (CALFED 2000). If this is the case, factors that could contribute to poor reproductive success include elimination of suitable breeding sites, predation on hatchlings by non-native predators, predation on eggs, diseases introduced by non-native turtles, and shortage of safe upland overwintering refuges (CALFED 2000). Due to its declining status, CALFED (2000) recognized the western pond turtle as a species that warrants conservation efforts, and its vision for this species is to increase, or at least not adversely impact, the abundance and distribution of its populations.

Surveys for western pond turtles were not conducted during preparation of the Delta Wetlands (DW) Project EIR/EIS and associated biological assessments, and no turtles were recorded during surveys for other species at the time (JSA 1995a). It was noted in the DW Project EIR/EIS, however, that western pond turtles had been observed using the blow-out pond on Holland Tract in the past and that potential habitat existed on all four DW project islands (Bacon Island, Bouldin Island, Holland Tract, and Webb Tract) (JSA 1995a). Aquatic habitat on the project islands' interiors consists primarily of blow-out ponds and irrigation ditches, while suitable upland habitat exists for the most part only on the perimeter levees and surrounding the blow-out ponds. Patches of aquatic vegetation, most often *Scirpus* sp. and/or *Egeria densa*, border all of the project islands, and to a certain extent they are all surrounded by in-channel islands.

One component of the In-Delta Storage Project involves strengthening the reservoir island levees (Bacon Island and Webb Tract). Two options are being considered: 1) riprap the entire interior side of the levee but only where needed on the exterior side (riprap option), and 2) where necessary, modify the existing levee into a bench and create an interior levee, which would have riprap on both its exterior and interior sides (bench option) (See the In-Delta Storage Project Feasibility Study engineering reports for a detailed description of the bench option). The modifications to the existing levee would involve removing the top of the levee leaving three possible bench elevations depending on what is needed. At the lowest elevation, emergent marsh vegetation would establish on the bench. At the mid-elevation, willow and alder dominated riparian vegetation would establish on the bench. At the highest elevation, cottonwood dominated riparian vegetation would establish on the bench. The amount of western pond turtle habitat that will be destroyed or created as a result of levee strengthening depends on how much is necessary and which option is employed. Additionally, all habitats on the interior of the reservoir islands will be lost as a result of project operations, but the habitats created on the habitat islands (Bouldin Island and Holland Tract) are intended to mitigate those losses. DWR biologists conducted an evaluation to identify the potential impacts to western pond turtles from the levee modification options.

Methods

Distribution and Habitat Use

During spring and summer 2002, DWR wildlife biologists and botanists conducted surveys for sensitive species on the In-Delta Storage Project islands and surrounding in-channel islands. Due to scheduling difficulties with boat and surveyor availability, some of the in-channel islands were not surveyed and none of the In-Delta Storage Project islands' interiors were surveyed specifically for western pond turtles. Boat surveys for western pond turtles were conducted on July 25th, August 23rd and 30th. These surveys consisted of a boat operator and an observer traveling around the perimeter of the project islands and some in-channel islands at varying rates of speed depending on the habitat quality searching for basking western pond turtles. When western pond turtles were observed incidentally during surveys for other species, they were recorded on most occasions. All recorded sightings of western pond turtles were mapped using digital georectified aerial photographs, taken by DWR in April 2001, as a basemap in ArcGIS. In addition, a search of the California Natural Diversity Database (CNDDB) provided locations for past observations, which were also mapped using this method (DFG 2002).

Quantification of Habitat

Aquatic Habitat: Locations of aquatic vegetation bordering the reservoir islands' (Bacon Island and Webb Tract) exterior levees were identified and measured linearly using the digital georectified aerial photographs in ArcGIS. Based on measurements made in ArcGIS and field observations, an average width of 8 meters was assigned to these distances to develop an estimate of area. Since no modification of the habitat islands' (Bouldin Island and Holland Tract) levees has been proposed, no loss of habitat around those islands is expected and no calculations of exterior side aquatic habitat were made. Areas of aquatic habitat, in the form of blow-out ponds and large irrigation canals, on the interior of all four islands were quantified using ArcGIS; however, the southwest section of Holland Tract was not included because it is not included in the project area. While smaller irrigation canals with intermittent water supplies represent potential western pond turtle habitat; they were not included because they are only marginally valuable at best due to their limited temporal availability.

Upland Habitat: Nearly 100% of the exterior side of the levees has been riprapped with what little natural vegetation that exists located near the crown. In addition, this side of the levee has the potential for inundation during flood years, which could destroy and/or displace nests and overwintering turtles. Therefore, for the purposes of this analysis, none of the land on the exterior side of the levee was included in the quantification of suitable upland habitat. Nearly 100% of the interior side of the levee on all four islands possesses natural vegetation at some point during the year. However, routine maintenance of these slopes may preclude successful nesting and typically removes woody vegetation that would improve the habitat for overwintering turtles. For the purposes of this analysis, approximately all of the land from the crown of the levee to the toe drain on the interior that was characterized by southern aspects and/or riparian vegetation was included in the quantification of suitable uplands. Any additional naturally vegetated uplands that could potentially support nesting and/or overwintering western pond turtles were also included in this quantification.

Proposed Habitat: The Habitat Management Plan (HMP)(JSA 1995b) details the types and quantities of habitat that may be created on the habitat islands. Modifications to the HMP may be necessary to meet mitigation requirements for giant garter snakes, Swainson's hawks and greater sandhill cranes. The proposed modifications for the HMP were not available at the time of this evaluation, so the evaluation is based on the descriptions of the habitat types in the existing HMP (JSA 1995b). Staff assessed the relative quality of 1995 HMP habitats to western pond turtles. The 1995 HMP, current literature, and personal observations on western pond turtle life history were used as a foundation. Seasonal pond, emergent marsh, permanent lake, canal, borrow pond, herbaceous upland, and riparian habitats are suitable for use by western pond turtles, while corn rotated with wheat, small grain crops, mixed agriculture/seasonal wetland, seasonal managed wetland, and pasture/hay are not. Quantities of currently available aquatic and upland habitat on the exterior of the reservoir islands and to the interior of all four islands were compared to the availability of aquatic and upland habitat in the 1995 HMP to assess whether the habitat islands would adequately mitigate impacts to western pond turtles and their habitat.

Results

Webb Tract

The exterior of Webb Tract and all of the surrounding in-channel islands were surveyed by boat for western pond turtles in 2002. Six western pond turtles were recorded on the exterior levee of Webb Tract, and one was observed using an in-channel island adjacent to the island (Figure 5-6). All of the turtles were observed basking on logs or other debris situated within patches of emergent vegetation. Most of the western pond turtles were found along Fisherman’s Cut where water flows are presumably slower than those of the surrounding rivers. Both of the observations outside of Fisherman’s Cut were along the San Joaquin River and had in-channel islands directly adjacent to them. No western pond turtles were observed on the interior of Webb Tract, and none were reported to the CNDDB in the immediate vicinity (DFG 2002).

Approximately 25% of Webb Tract’s 21 km (13 mile) perimeter levee, or approximately 4 ha (10 acres), is bordered by shallow water with aquatic vegetation. On the interior of Webb Tract, approximately 35.5 ha (88 acres) of canal and associated bankside constitute suitable western pond turtle habitat. In addition, the two large blow-out ponds and one small borrow pond total approximately 35 ha (87 acres) of aquatic habitat. There are approximately 140 ha (347 acres) of upland suitable for nesting and/or overwintering. All suitable habitat on the interior of the island will be lost when the project is operational. If the riprap option is implemented, up to 10 acres of exterior aquatic habitat could be lost at the toe of the existing levee. If the bench option at the lowest elevation is employed, there will be no loss of exterior aquatic habitat because we assume the aquatic habitat and the toe of the levee will be untouched. Nevertheless, the quality of this habitat will greatly diminish due to the loss of the adjacent uplands that will be riprapped under this option. In areas where either the mid-elevation or high-elevation benches are created, a net loss of suitable habitat will occur because neither of these habitats will be very useful to western pond turtles and, therefore, cannot be considered replacement habitat.

Bacon Island

Only the exterior of Bacon Island was surveyed by boat for western pond turtles. The in-channel islands surrounding most of Bacon Island were not formally surveyed for this species; however, there were past observations of many western pond turtles using these islands in the CNDDB (DFG 2002), and they continue to represent high quality habitat. Five western pond turtles were recorded in four locations on the exterior levee of Bacon Island in 2002, and one western pond turtle was observed basking on a large branch inside the main north-south canal on the interior of the island (Figure 5-7). One of the western pond turtles on the exterior levee was observed basking on a diversion pipe.

Approximately 75% of Bacon Island's 23 km (14 mile) perimeter levee, or approximately 14 ha (34 acres), is bordered by shallow water with aquatic vegetation. On the interior of Bacon Island, approximately 35 ha (86 acres) of canal and associated bankside, as well as approximately 28 ha (70 acres) of upland, constitute suitable western pond turtle habitat. All of this interior habitat will be lost as a result of this project. If the riprap option is implemented, up to 34 acres of exterior aquatic habitat at the toe of the existing levee could be removed. If the bench option at the lowest elevation is employed, there will be no loss of exterior aquatic habitat (assuming that the aquatic habitat at the toe of the levee will remain untouched); however, the quality of this habitat will greatly diminish due to the loss of the adjacent uplands that will be riprapped under this option.

Bouldin Island

The exterior of Bouldin Island and some of the surrounding in-channel islands were surveyed by boat for western pond turtles in 2002. Fourteen western pond turtles were recorded on the exterior levee of Bouldin Island, and three were observed using an in-channel island on the south side of the island (Figure 5-8). Most were observed basking on logs situated within patches of emergent vegetation. Two western pond turtles were observed across from Tower Park Marina; one was basking on a diversion pipe, and the other was submerged surrounded by a patch of *Egeria densa*. One western pond turtle was found dead on the levee road near Highway 12 on the western side of the island. While no western pond turtles were observed using the in-channel islands on the north side of Bouldin Island during the 2002 surveys, relatively large numbers were recorded there in 1994 (DFG 2002). In addition, a western pond turtle was observed in one of the irrigation ditches near Highway 12 in 2001 (DFG 2002).

The interior of Bouldin Island currently possesses approximately 59 ha (147 acres) of canal and associated bankside, as well as 62 ha (153 acres) of upland, that represent suitable western pond turtle habitat. In addition, there are three borrow ponds that appear to hold water most of the year, totaling approximately 10.5 ha (26 acres) of emergent marsh habitat. According to the HMP, 66 acres of seasonal pond, 208 acres of emergent marsh, 111 acres of permanent lake, 70 acres of canal, 89 acres of borrow pond, 479 acres of herbaceous upland, and 170 acres of riparian habitat will either be created or preserved on Bouldin Island (JSA 1995b).

Holland Tract

The exterior of Holland Tract and most of the surrounding in-channel islands were surveyed by boat for western pond turtles in 2002. Nine western pond turtles were recorded on the exterior levee of Holland Tract, and three were observed using the in-channel islands surrounding the island (Figure 5-9). Most were observed basking on logs or diversion pipes in Sand Mound Slough, where the water is shallow and flows slowly, boat traffic is light and slow, and emergent vegetation is abundant. Other than the western pond turtles that had been reported using in-channel islands located between Holland Tract and Bacon Island, the CNDDB only had one other record of a western pond turtle in the vicinity of Holland Tract (DFG 2002). It was observed basking on a log near the southwestern corner of Holland Tract (DFG 2002). Three turtles were recorded on the island’s interior; one was seen basking on a log in the blow-out pond on November 13th, and two were seen in one of the large east-west irrigation ditches.

The portion of Holland Tract that is included in this project currently possesses approximately 23 ha (58 acres) of canal and associated bankside, as well as 67.5 ha (167 acres) of upland, on its interior that constitute western pond turtle habitat. In addition, there is a large blow-out pond totaling approximately 5.5 ha (13 acres). According to the HMP, 68 acres of seasonal pond, 194 acres of emergent marsh, 33 acres of permanent lake, 10 acres of canal, 253 acres of herbaceous upland, and 217 acres of riparian will be either be created or preserved on Holland Tract (JSA 1995b).

Potential Impacts

Because the survey effort to date has been inadequate to ascertain precisely how valuable each of the DW islands are to western pond turtles, it is difficult to determine whether the mitigation strategies proposed in the Habitat Management Plan will sufficiently mitigate project impacts. Fortunately, based on the survey results it appears that, in general, more western pond turtles are using the proposed habitat islands than the proposed reservoir islands. This could be due in part to the fact that both islands have marinas on or adjacent to them where boat speeds are not supposed to exceed 5 mph. In addition, Holland Tract is bounded by Sand Mound Slough on the west, which is shallow and heavily vegetated with slow-flowing to still water and relatively slow boat speeds.

It appears that the habitat islands will sufficiently mitigate losses to western pond turtle aquatic habitat but possibly not upland habitat. Approximately, 261 acres of suitable aquatic habitat will be lost from the interior of the reservoir islands and as much as 44 acres on the exterior. However, 849 acres of seasonal ponds, emergent marsh, permanent lakes, canals, and borrow ponds will be created or preserved on the habitat islands. Of this 849 acres, approximately 244 acres already exists, which means 605 acres will be created as mitigation for the up to 305 acres lost. Approximately 417 acres of suitable upland (herbaceous upland and riparian) habitat will be lost from the interior of the reservoir islands, and approximately 320 acres of upland habitat currently exists on the habitat islands. The HMP proposes to create or preserve a total of 1,119 acres of herbaceous upland (732 acres) and riparian (387 acres) vegetation. Unfortunately, most of this herbaceous upland is located on the perimeter levees. This habitat already exists, so it should not be considered compensation for losses on the reservoir islands. In addition, not all of these upland habitats are suitable for nesting and/or overwintering, so the total amount created and/or preserved in the HMP is an overestimate of the amount of habitat that would actually benefit western pond turtles.

If the total amount of herbaceous upland cannot be increased, reconfiguration of the current acreages could improve the chances of western pond turtles successfully nesting on the habitat islands. Currently, there are three north-south patches of upland proposed on Bouldin Island. If these were rotated so that they ran east-west and were given a low to moderate slope, it would create a south-facing slope which has the potential to be used by nesting turtles. In addition, part of one of these “uplands” is slated to become a borrow pond, which would further decrease the amount of uplands available. An effort should be made to create herbaceous uplands with south-facing slopes around all permanent lakes, ponds, and emergent marsh habitats. These important aquatic habitats can be further enhanced by placing logs around the perimeter to create basking habitat.

In addition to the deficiency of suitable nesting habitat, some of the scheduled maintenance activities may preclude successful nesting by western pond turtles in areas where it actually exists. For example, exterior and interior levee maintenance is scheduled for late-spring through August, but this is the time when western pond turtles are nesting. As the habitat islands are currently designed, the vast majority of suitable nesting habitat is located on the perimeter levees and would be disturbed by these activities. Since hatchlings most likely overwinter in the nest, winter is not a good time for levee maintenance. If suitable uplands cannot be created around the lakes, ponds, and emergent marsh, then conducting maintenance of the levees after the hatchlings have emerged but before the females are attempting to nest (mid-April through mid-May) should be included in the management plan.

Recommendations

- The revised HMP proposes to develop 216 additional acres of herbaceous uplands than what is in the 1995 HMP. The herbaceous uplands should be designed to provide nesting and overwintering habitat for the western pond turtle.
- The revised HMP proposes to develop about 200 more acres of suitable emergent marsh than what is in the 1995 HMP. Emergent marsh habitat should be designed to provide suitable habitat for the western pond turtle.

Figure 5-6. Webb Tract Western Pond Turtle Occurrences and Habitat

Figure 5-7. Bacon Island Western Pond Turtle Occurrences and Habitat

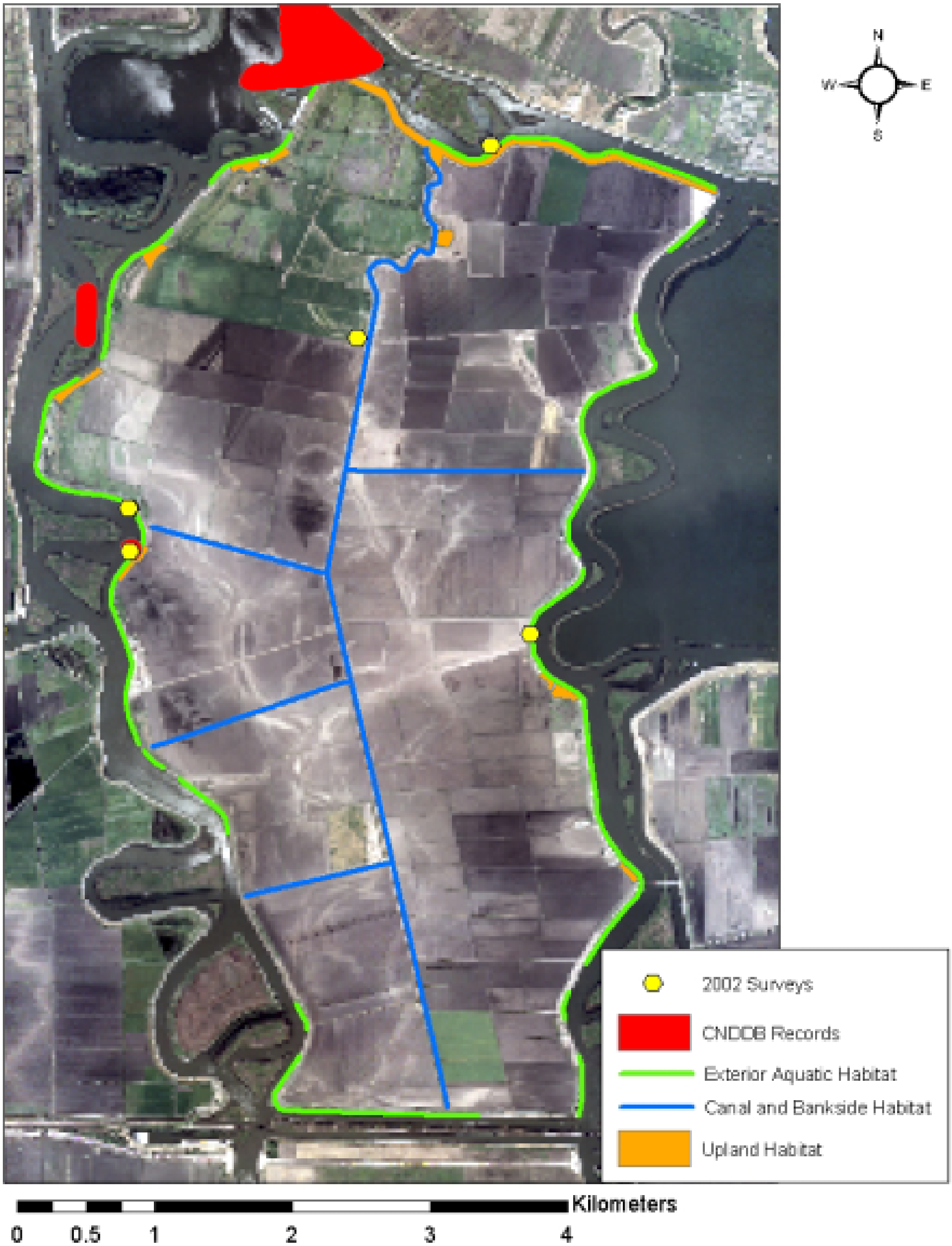


Figure 5-8. Bouldin Island Western Pond Turtle Occurrences and Habitat

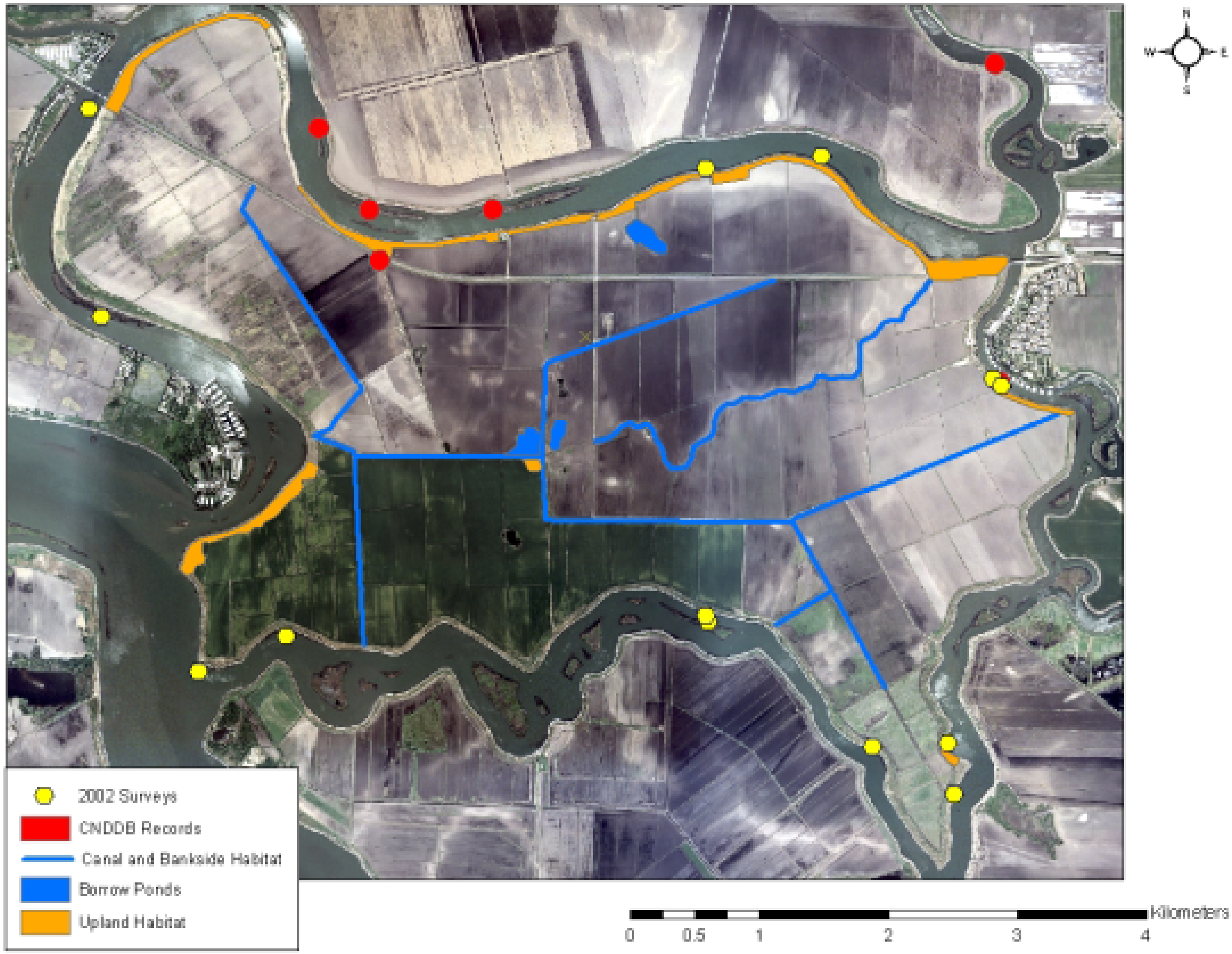
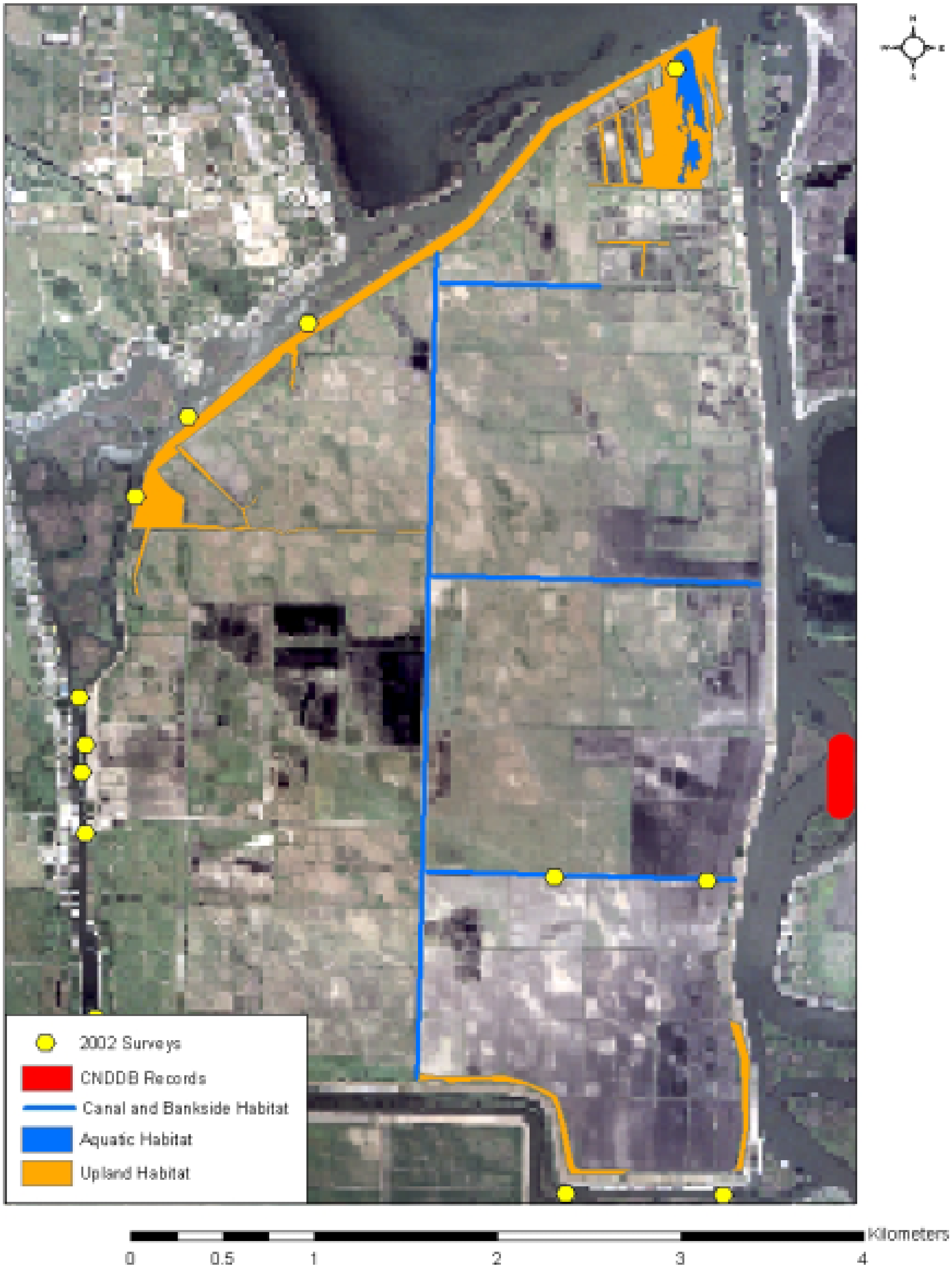


Figure 5-9. Holland Tract Western Pond Turtle Occurrences and Habitat



Greater Sandhill Crane

There are three subspecies of sandhill crane that migrate each fall to the Central Valley of California to spend the winter, the lesser (*G.c canadensis*), Canadian (*G.c. rowani*), and greater (*G.c. tabida*). The greater sandhill crane was classified as a State Threatened species in 1983 under the California Endangered Species Act.

The Central Valley population is one of five distinct greater sandhill crane populations. Central Valley population cranes breed in northeastern California, central and eastern Oregon, southwestern Washington, and southern British Columbia, and migrate to California's Central Valley for the winter. Pogson (1990) recorded 5,129 greater sandhill cranes and Canadian cranes wintering in the Delta in January 1984. This means that over 61% of the Central Valley population of 8,500 (Littlefield and Ivey 2000) greater sandhill cranes used the Delta in 1984. In 1984 the majority of cranes in the Delta were located in the Thornton region, where 3,829 (45% of the population) cranes were observed. The major crane use areas in the Delta include the Woodbridge Ecological Reserve, Staten Island and the Cosumnes River Floodplain. These areas accounted for over 86% of the greater sandhill crane use in January 1984 (Pogson 1990).

Greater sandhill cranes start arriving in the Central Valley in mid-to-late September, but most arrive between mid-October and late November. Pogson (1990) observed a shift in cranes from the Sacramento Valley to the Delta in November and December 1983. The Sacramento-San Joaquin Delta is one of two most important areas in the Central Valley for greater sandhill cranes (Pogson 1990).

Littlefield and Ivey (2000) reported that wintering habitat for greater sandhill cranes consists of secure roosting and loafing habitats close to grainfields. Also, cranes roost in shallow, open water and obtain carbohydrates from grain crops, and protein, calcium and other nutrients from grassland, pastures and alfalfa. Cranes leave night roost early in the morning to feed in grain fields. In the mid-day cranes usually loaf and occasionally feed in pastures, alfalfa fields, along canals, levees, ditches, and dikes or use the shorelines or shallows of ponds, lakes, or other wetlands. In mid-afternoon cranes return to grainfields for feeding. Cranes return to roosting areas in the early evening.

There is little published data on crane use on In-Delta Storage Project islands. Jones and Stokes biologists conducted several crane surveys on Bouldin Island for the DW Project:

- Ground surveys in February 1989 to May 1989 and October 1990, and

∉ Aerial surveys in November 1988, December 1989 to May 1989.

Biologists found an average of 84 (n=4) greater sandhill cranes on Bouldin Island in February 1989 and an average of 1 (n=2) greater in March 1989 during ground surveys. Results from the aerial surveys showed an average of 33 (n=3) in November 1988, 106 (n=5) in December 1989, 29 (n=3) in January 1989, 27 (n=4) in February 1989. JSA (1995a) found 1 crane on Webb Tract during 1989 surveys.

DWR staff conducted sandhill crane surveys on the In-Delta Storage Project islands from September 2002 - February 2003.

Survey Objectives

∉ Estimate the number of greater and lesser sandhill cranes that winter on In-Delta Storage Program Islands

∉ Determine habitat types used on project islands

Methods

Sandhill crane surveys for the In-Delta Storage Project islands followed the methods described in Pogson (1990). The author conducted 22 roadside surveys from the end of September 2002 to the first week of February 2003. I conducted six surveys on Webb Tract and Bouldin Island and five surveys on Bacon Island and Holland Tract. I counted cranes from levee and main roads on the four islands. Survey dates and locations are shown in Table 5-5.

The author searched the entire project island once each survey for cranes by stopping every 0.5-2 km and scanning for cranes with binoculars or a spotting scope. The number of observations and specific observation points varied and were determined by the location and density of cranes, visibility, vegetation, and island configuration. Specific observations were made in each grainfield or similar habitat type that contained cranes. Landscape features (i.e. roads, ditches, and vegetation) were used to define the area included in each observation. An observation number was recorded on a map to keep track of area surveyed. Observations were made from specific locations that provided the clearest views without disturbing cranes.

The author counted cranes by subspecies at each location present and recorded habitat types. I counted greater and Canadian cranes as one subspecies because they are not always distinguishable in the field. I distinguished lesser sandhill cranes from the "Large" cranes by their small body size, shape of their heads, the length and shape of their bills, and the length of their bills relative to the size of their heads. I was unable to determine subspecies of some cranes because they were too far from the observation point or were obscured by vegetation; I counted these cranes as "unknown".

There is the possibility that I counted some cranes twice. For example, cranes may have flown from an area on the island that was previously counted to an uncounted area. However, it is equally likely that some cranes flew away before being counted. Also, it is equally likely that cranes flying could have come from a different island. In instances when counted cranes were observed flying into an uncounted area, the counted cranes were subtracted from the total. The number of cranes counted during each survey is an estimate and is not intended to be an absolute value.

Table 5-5. Dates of winter crane surveys for 2002-2003.

Survey Period	Bouldin Island	Webb Tract	Bacon Island	Holland Tract
1	9/30	-	10/3	10/2
2	10/15	10/18	10/17	-
3	11/12	11/14	11/15	11/13
4	11/25	11/26	-	-
5	-	12/10	-	12/11
6	1/21	1/23	1/24	1/22
7	2/3	2/4	2/6	2/5

Blank cells indicate no surveys were conducted.

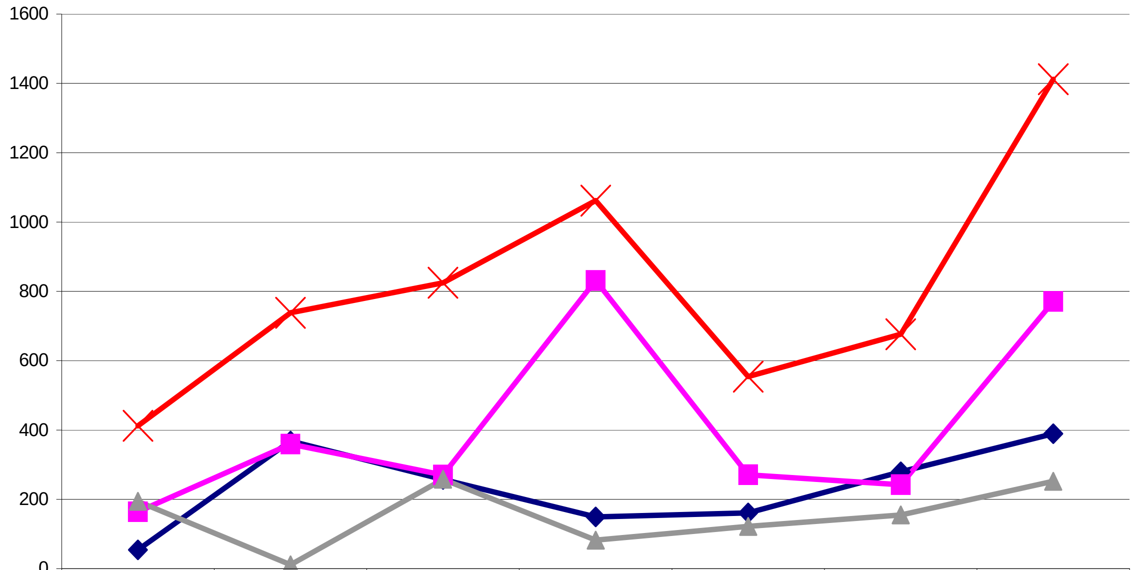
Results and Discussion

Greater sandhill cranes used all project islands through out the 2002-03 fall and winter. The number of cranes observed for each survey period is presented in Figure 5-10. The number of cranes on the project islands increased through the end of November, dropped in December and January, and reached the maximum number observed for the season in February 2003. I observed the maximum number of cranes (1412) and the maximum number of greater sandhill cranes (389) in February 2003. The number of lesser sandhill cranes exceeded the greater sandhill cranes during every survey except two. There were 10 times more lessers than greaters on the project islands in November. The total number of greater sandhill cranes observed on the project islands ranged from 0.64% - 4.58% of the Central Valley population.

The number of cranes that use each island varied from island-to-island and varied through the season (Figure 5-11). The average number of cranes I observed during the 2002-03 surveys was 653.5 (SE = 91.0) on Webb Tract, 201.8 (SE = 59.2) on Bouldin Island, 60.6 (SE = 39.8) on Bacon Island, and 60.8 (SE = 47.4) on Holland Tract. As expected, cranes were more abundant on the northern project islands (Webb & Bouldin) than the southern project islands (Bacon & Holland). Ninety-one percent on average of the sandhill cranes counted occurred on Webb and

Bouldin and about 9% on average occurred on Bacon and Holland. Webb and Bouldin are much closer than Holland and Bacon (about 8 and 10 miles, respectively) to traditional crane roosting locations on Staten Island and the Thornton area. Cranes have roosted in these traditional sites for at least 30 years (Littlefield and Ivey 2000).

Figure 5-10. Number of sandhill cranes counted on Project Islands from September 2002 - February 2003.



	1	2	3	4	5	6	7
Greater	54	368	257	149	161	279	389
Lesser	164	359	270	831	271	242	771
unknown	194	11	258	82	122	155	252
Total	412	738	825	1062	554	676	1412

The numbers of large sandhill cranes counted were significantly greater on Webb Tract than Bouldin Island ($P < .05$), although Webb Tract is approximately 3 miles from Staten Island and Bouldin Island is adjacent to the south side of Staten Island. Webb Tract contained 69% of the large cranes on average each time it was surveyed, while Bouldin contained 35% each time it was surveyed. A possible reason for the larger number of cranes on Webb Tract is that they were roosting on the island. A large open area on Webb Tract was flooded in the winter 2002-2003 (Figure 5-12). The flooded area provided habitat for numerous waterfowl species, and sandhill cranes were frequently observed around this area. Webb Tract's land manager reported hearing cranes at night during the 2002 - 2003 winter (J. Winter personal communication; see "Notes"). This suggests that cranes were roosting on the island.

Figure 5-11. Number of Sandhill Cranes Observed on each Project Islands Winter 2002-2003.

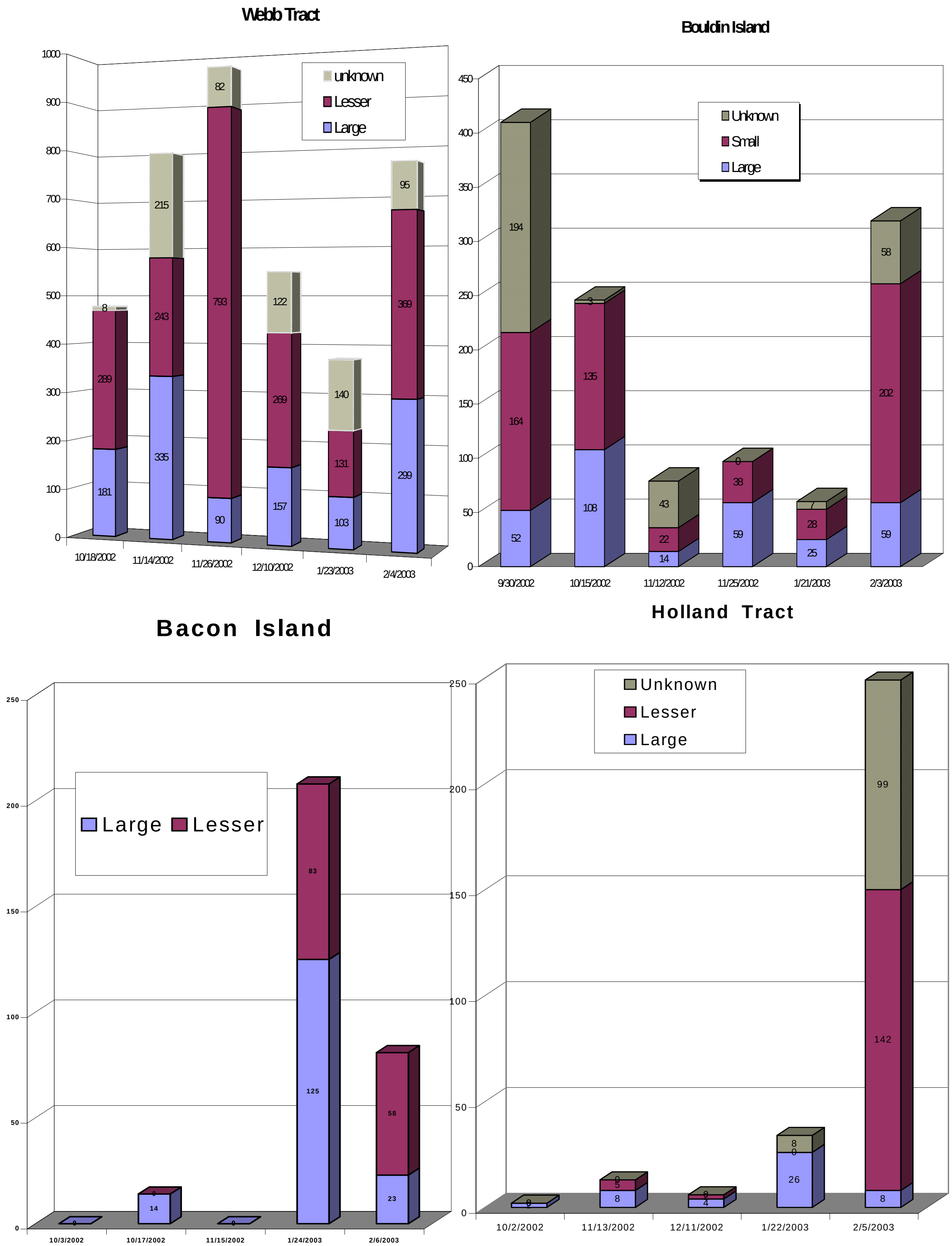


Figure 5-12. Seasonal Managed Wetlands on Webb Tract Winter 2002-2003.

Crane use on Bacon and Holland was minimal in the early part of the season, but increased during January and February. Approximately 95% and 93% of all cranes observed on Bacon and Holland, respectively, were there in January and February. A relatively small number of cranes used both Holland and Bacon during the winter of 2002-03. If the cranes roosted on Staten Island they would have to fly 16-20 miles round trip to forage on Holland and Bacon. No cranes were reported on Holland and Bacon by JSA during surveys for the Delta Wetlands Project in 1988.

Sandhill cranes were observed using six different habitat types on the project islands. The farmers on Bouldin, Webb, and Bacon manage the islands primarily for row crops. The habitat types and the average percentage of use by greater sandhill cranes are shown in Figure 5-13. Corn and wheat were the main crops grown on Bouldin and Webb in 2002. There was also a substantial amount of grasslands and seasonal managed wetlands on Webb Tract. Seasonal managed wetlands were flooded harvested wheat fields or fallow fields with constructed levees. The main crops grown on Bacon Island included corn, wheat, sunflower, potato, and asparagus. Many of the fields on Bacon were immediately disced and leveled after harvesting. Crops were not planted on Holland Tract during 2002; it was managed as pasture for livestock grazing. A portion of the pasture on Holland Tract was flood irrigated through the fall.

Greater sandhill cranes were observed foraging predominately in wheat and cornfields (78%). There was no significant difference between the number of greater sandhill cranes foraging in wheat or cornfields. Grassland habitats were also used on average 18% of the time. The remaining habitats were only used about 4% on average.

Figure 5-13. Percent of Greater Sandhill Cranes Observed by Habitat Types - Winter 2002-2003

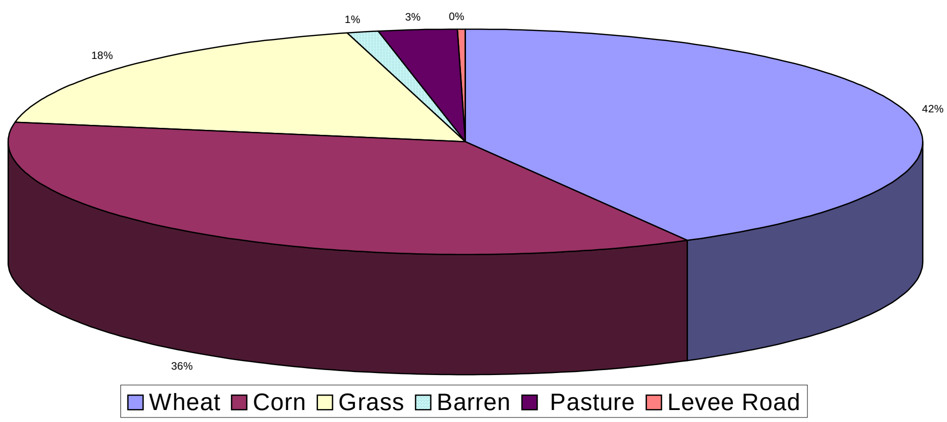


Figure 5-14 illustrates that greater sandhill cranes used wheat fields heavily in the fall and less through the winter. The percentage of cranes using cornfields peaked in the 4th survey period, dropped in the 5th survey period, then came back up in the last survey period. The overall trend for greater sandhill cranes using cornfields showed an increase from fall through the winter. A regression analysis (Figure 5-15) suggests that there was a positive relationship between the percentage of greater sandhill cranes foraging in cornfields (R^2 = 0.6951) and the survey period. Another regression analysis suggests that there is a negative relationship between the percentage of greater sandhill crane foraging in wheat fields and the survey period (R^2 = 0.6947).

Grasslands were used throughout the season. Grassland habitats included levee slopes, areas at the base of the levee that were not in agriculture, and patches of grass growing between agriculture fields. A few cranes on Webb Tract were observed in areas that had been flooded but were drained and had no vegetation. Two greaters were observed on Bouldin Island's levee road in an area covered with gravel, an important source of grit for cranes (Littlefield and Ivey 2000).

Figure 5-14. Greater Sandhill Crane Habitat Use by Survey Period.

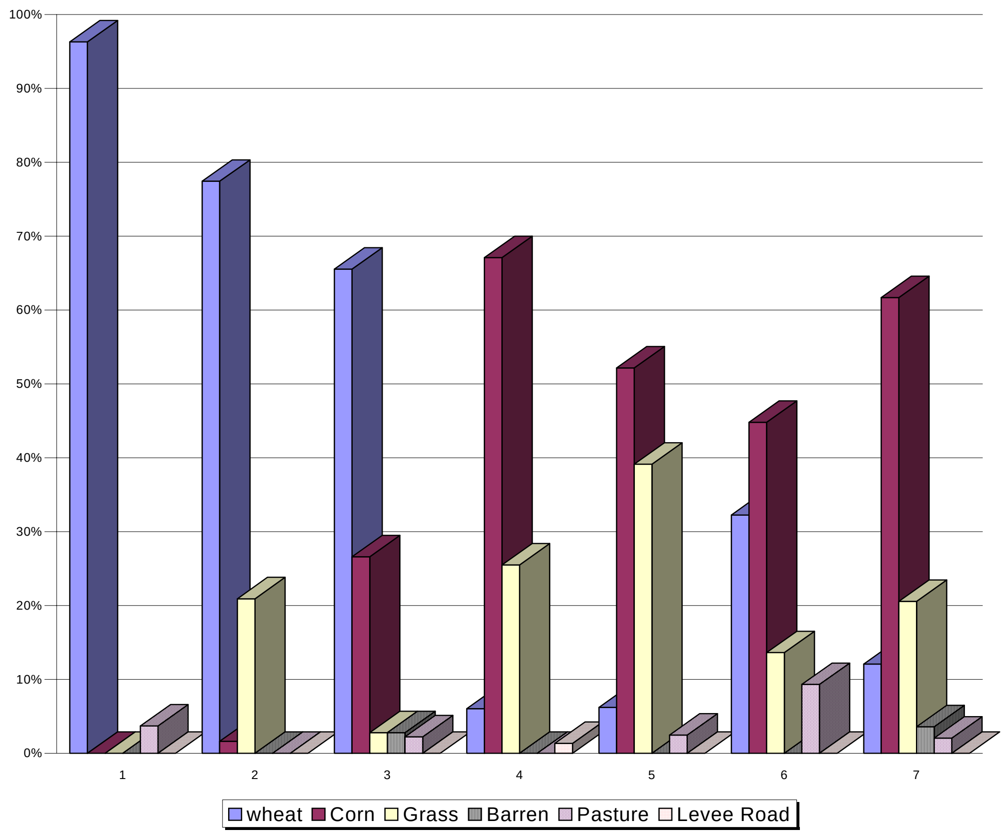
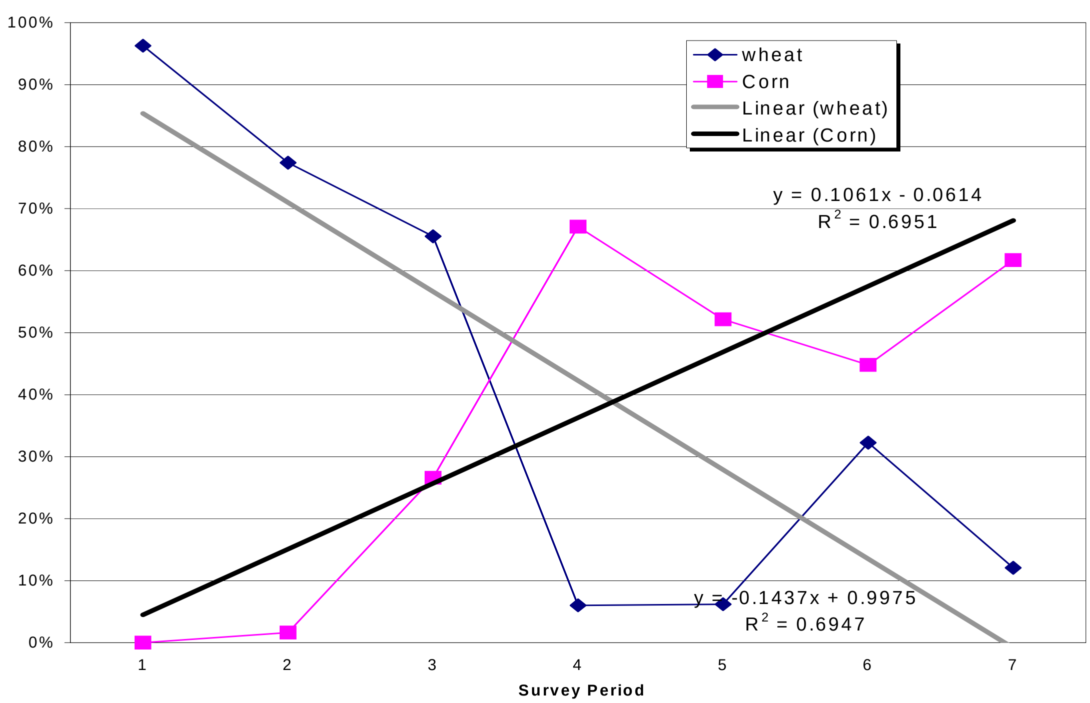


Figure 5-15. Regression Analysis of Crane Use of Corn and Wheat.



The information presented in Figures 5-13 and 5-14 indicates that the availability of grains for forage throughout the winter is important for meeting the greater sandhill cranes needs on the In-Delta Storage Project islands. Furthermore, the importance of grains along with diverse habitat types, such as seasonal wetlands, grasslands and pasture, should be considered in the development of compensation objectives for the greater sandhill crane.

Potential Impacts

Methods

The amount and type of suitable sandhill crane habitats that would be lost from implementing the In-Delta Storage Project were determined from the 1995 & 1996 DWR Land Use (DWR 2002) and the 1987 habitat information presented in the DW Project Environmental Impact Report and Environmental Impact Statement (JSA 1995a), and the revised Habitat Management Plan presented later in this chapter. Suitable crane habitat types listed in the 1995 HMP were used for this analysis (JSA 1995b). The 1987 habitat information was used to modify 1995/96 land use data to more accurately reflect habitat conditions in the following situations:

- The 1987 figures for water surface were used because the 1996 data did not include canals.
- Riparian vegetation was increased on all islands except Holland because the 1996 data did not include many areas that were present in both 1987 and 2002. These figures are estimated from the 1995 & 1996 DWR Land Use Maps and 2001 aerial photographs.
- Developed acres were increased to 1987 figures because the 1996 data did not include highways and other areas that are currently present and were present in 1987.
- Native Vegetation was reduced by the amount added to water surface, riparian, and developed acres.

There is still a large amount of variability between the 1987 and 1996 figures and this analysis is an estimate based on the best available information.

The amount of corn available for forage that would be lost on the reservoir islands from implementing the In-Delta Storage Project were determined based on 1996 habitat conditions. We determined the amount of corn available for forage in 1996 by multiplying the mean pounds per acre figures presented in 1991 Preliminary Draft Habitat Evaluation Procedures (HEP) Report for the Delta Wetlands Project (Table 2-4) by the acres of corn grown 1996. We assumed that the same ratios of disced to undisced fields presented in the HEP occurred in 1996.

The pounds of forage corn lost on the habitat islands from implementing the revised HMP were determined for 1996 habitat conditions by:

- Calculating the percentage of suitable habitat lost,
- Assuming all suitable habitats would be reduced by the same percentage,
- Determining the pounds of forage corn present in 1996 (the same method as used in the Reservoir Islands analysis).

The amount of wheat available for forage that would be lost on the reservoir islands from implementing the In-Delta Storage Project was estimated based on 1996 habitat conditions. We assumed that 52 pounds of wheat per acre would be available for forage. This is equivalent to 1 bushel of wheat (dry weight) per acre that would be left in the field after harvesting (Hirning et al 1987, Ogburn and Donald 1983). We did not differentiate the amount of forage available between disced and non-disced fields. We estimated the pounds of wheat lost on the Habitat Islands from implementing the revised HMP by using the procedures from the corn analysis.

Results

Potential impacts to greater sandhill cranes were determined by evaluating the 1995/96 habitat types and available forage on the project islands and comparing it to the habitats and available forage that would be developed on the habitat islands. We used the 1995/96 DWR Land Use data presented in the 2002 In-Delta Storage Program Draft Report on Environmental Evaluations (DWR 2002) for this analysis because they are the best available information. The impact to different sandhill crane habitats is presented in Table 5-6. Corn and wheat account for 89% of the habitat type being lost on the project islands. The DWR land use category Native Vegetation consists of mostly non-native grasses located on the interior levee and at the base of levees. Seasonal managed wetlands were present on Webb Tract during the 2002-2003 winter (Figure 5-12). These areas were included as wheat or corn in the DWR 1996 land use data. Flooding the reservoir islands would eliminate all habitat types used by sandhill cranes for a total of 8,554 acres. Implementing the revised HMP would eliminate 5, 848 acres of greater sandhill crane habitat on the habitat islands and 1,116 acres of this would be replaced with habitat types (i.e. emergent wetlands, riparian vegetation, and permanent ponds) that are not suitable for cranes. Suitable habitats added to the habitat islands include 2,860 acres of alfalfa for Swainson's hawks and 1,339 acres of herbaceous uplands for giant garter snakes. There are a total of, 10,595 acres of sandhill crane habitat that would be lost from implementing the In-Delta Storage Project. There was an increase of 2,624 acres (38%) in 1996 from the suitable crane habitat available in 1988.

Table 5-6. Acres of Sandhill Crane Habitat Impacted

			Acres Lost			
Island Type	Wheat	Corn	Other Grains	Idle/fallow	Native Vegetation	Total
Reservoir	2,772	4,948	71	130	633	8,554
Habitat	1,266	3,588	991	3	0	5,848
Total	4,038	8,536	1,062	133	633	14,402
			Acres of Suitable Habitat Added			
Island				Alfalfa	Herbaceous Uplands	
Bouldin				1925	543	2468
Holland				935	404	1339
Total				2860	947	3807
Net Acres lost						10,595

The ratio of crane habitat would shift from grains to alfalfa/grasslands under the In-Delta Storage Project. In 1996 grains accounted for about 92% of the suitable crane habitat, while grasslands and fallow areas comprised about 8% of the habitat. Under the In-Delta Storage Project suitable crane habitat would be comprised of 34% grains and 66% alfalfa/grasslands.

The loss of forage, specifically the loss of corn and wheat, could be used to measure the impacts on crane foraging. Several reports suggest that increased use of sandhill cranes in the Sacramento-San Joaquin Delta is the result of increased production of corn and other grain products (Pogson 1990, Littlefield and Ivey 2000, 2002). Looking solely at the acres of grain lost does not fully illustrate the forage impacts to sandhill cranes. What is available for cranes to consume is also important. Different farming practices determine how much waste grain is available for cranes and other wildlife species to consume. Cranes look for waste grain on the soil surface, thus discing soils, removing stubble, and flooding grain fields reduces the amount of grains available for forage (Littlefield and Ivey 2000). The amount of corn and wheat that would be lost from implementing the In-Delta Storage Project is presented in Table 5-7. About 1.3 million pounds of corn and about 210,000 pounds of wheat would be lost on the project islands.

The In-Delta Storage Project would acquire 3,900 acres of conservation easements for Swainson's hawks. The objective of the conservation easements is to convert low quality Swainson's hawk habit, such as corn, to harvested alfalfa and wheat. This potentially can further reduce the amount grains available for forage. As corn and wheat crops are reduced in the Central Valley, the importance of the grain crops in the Delta for sandhill cranes becomes more important.

Table 5-7. Pounds of Grain Impacted

Crop	Islands	Acres In 1996	Pounds Available for forage	Pounds per acre	Acres Lost	Total Pounds Lost
Corn	Reservoir	4948	891,132	180.1	4948	891,132
	Habitat	4033	437,223	108.4	3588	388,991
Total		8981	1,328,355	147.9	8536	1,280,123
Wheat	Reservoir	2772	144,144	52	2772	144,144
	Habitat	3086	160,472	52	1266	65,832
Total		5858	304,616	52	4038	209,976

Swainson's Hawk

Swainson’s hawks (State listed Threatened) occur throughout the Sacramento-San Joaquin Rivers Delta, with concentrations in the north and south Delta. The central Delta has a reduced density by comparison, probably resulting from the poor usability of the crops grown there. Swainson’s hawks in California’s Central Valley have become reliant on specific crop types with specific cultivation practices; the species has all but abandoned its historic use of grassland habitats. All four of the Delta Wetlands Islands provide usable foraging habitat for Swainson’s hawks, which is indicated by the number of Swainson’s hawk nests located on or adjacent to each island (Figures 5-15 and 5-16).

Nesting Surveys

Nesting surveys were completed in 2002 and 2003, although they were not protocol level surveys. Even so, 3 nest sites and 2 nest territories were identified on Webb Tract and 2 nest sites and 2 nest territories were identified on or immediately adjacent to Bacon Island (Figure 5-16 and 5-17). The replacement of nest trees/sites will be achieved in the required replacement of wetland habitat components, and no additional mitigation for nesting is expected with the potential exception of additional trees planted along fields well away from wetland areas.

The observed nest sites are in close proximity to 100% of the available forage on both reservoir islands and thus all available foraging habitat would be subject to mitigation under DFG guidelines for Swainson's hawk mitigation.

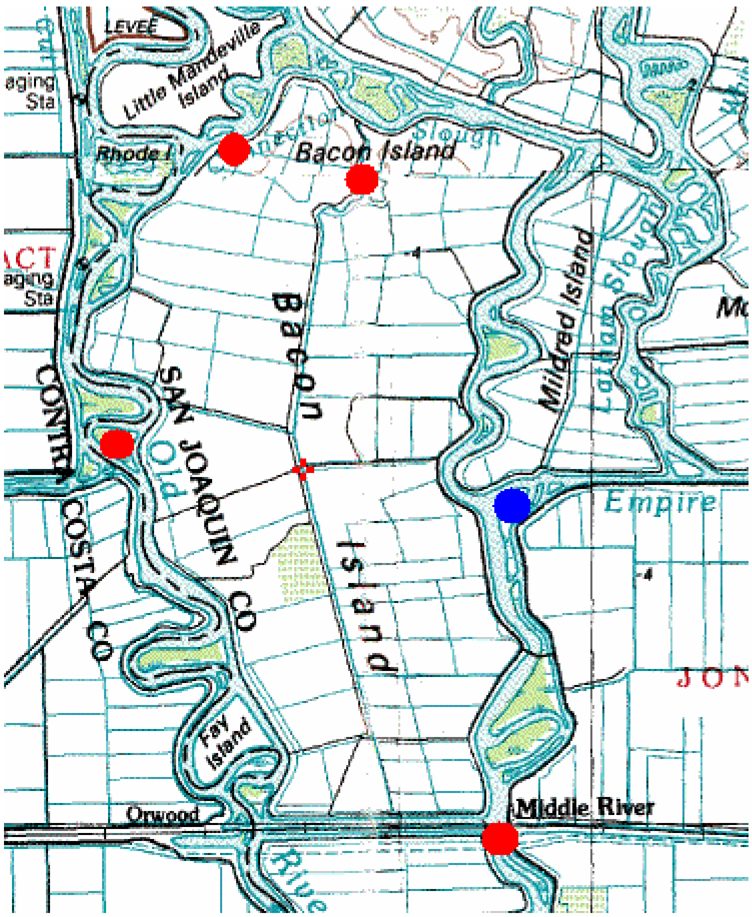


Figure 5-16. Swainson's hawk nests identified on or near Bacon Island in April 2002 (Red dots indicate established nesting territories. The blue dot indicates a sighting of an individual Swainson's hawk. We could not confirm establishment of a nest at the blue dot location later in the season because of funding limitations.)

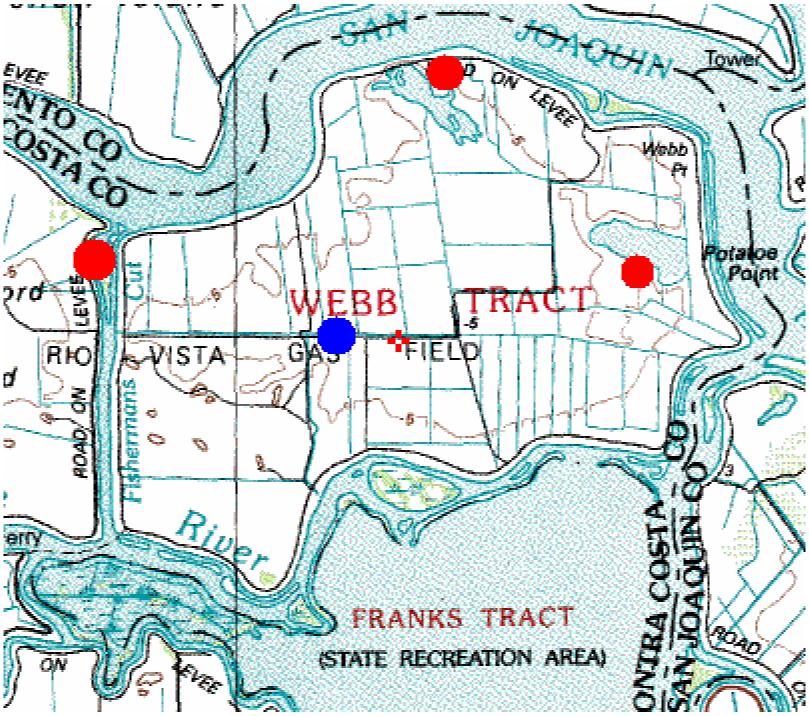


Figure 5-17. Swainson's hawk nests identified on or near Webb Tract in April 2002 (Red dots indicate established nesting territories. The blue dot indicates a sighting of an individual Swainson's hawk. We could not confirm establishment of a nest at the blue dot location later in the season because of funding limitations.)

Habitat Assessment

The Delta Wetlands Project includes four central Delta islands: two reservoir islands which have approximately 5310 acres and 5032 acres of Swainson's hawk foraging habitat (Bacon Island and Webb Tract, respectively); and two habitat (mitigation) islands which have approximately 5653 acres and 2868 acres of Swainson's hawk foraging habitat (Bouldin Island and Holland Tract, respectively). The total amount of Swainson's hawk foraging habitat on the 4 islands is 18,863 acres as determined from DWR's 1996 Land Used Data Base, and which is considered the baseline condition for this project.

The flooding of the two reservoir islands would result in the net loss of 10,342 acres (55%) of Swainson's hawk foraging habitat for all project lands. CEQA requires a finding of significant environmental effect if a State or federally listed species is likely to be reduced in number, and requires mitigation to offset the impact to the greatest extent feasible. The loss of more than 10,000 acres of foraging habitat would likely result in a reduction in numbers of Swainson's hawks in the immediate project area.

Swainson’s hawk experts recognize that the loss of gross acres of foraging habitat may be offset by improving the foraging opportunities on mitigation lands. For instance, the loss of 1000 acres of corn (which has little forage value for Swainson’s hawks) may be mitigated by replacing a second 1000 acres of corn with alfalfa (which has high forage value), given that the mitigation land is in reasonable proximity to the Swainson’s hawk nest sites of concern.

To determine the level of impacts to Swainson’s hawks relative to foraging habitat loss on the reservoir islands, the specific crop types typically grown on each island (at 1996 baseline) must also be considered; different crops have differing levels of usefulness by the species (DFG, 1994). Flood-irrigated alfalfa is the crop most used by Swainson’s hawks, per unit volume. Alfalfa’s 3 to 4 year growing cycle supports large populations of small mammals, especially voles, and flood-irrigation, mowing and baling of the hay makes those prey readily available to the hawk. Recent Swainson’s hawk use data indicate that Swainson's hawks use alfalfa 10 to 100 times more often than almost all other crops. (Swolgaard, 2002 unpublished data). Because of the excellent forage value of alfalfa, it has a value factor of 4.

Although Swainson’s hawks use alfalfa at a rate many times that of other crops, the increase in value of any crop is greatly limited by the reduction in the size of the foraging area, as per the fundamental principals of island biogeography. A linear reduction of land area results in a geometric reduction of prey, based on the number of species and the population of each species. The principals of island biogeography also indicate that increased habitat diversity results in increased numbers of species, which likely increases stability to foraging habitat; a mixture of alfalfa and other high value forage crops would be preferable to alfalfa alone. In addition, a mixture would reduce the potential for the loss of alfalfa grown in other areas of the Swainson’s hawk’s range due to a significant increase of alfalfa added to the market from project lands.

Crops/land uses that provide good forage opportunities include wheat, tomatoes, and sugar beets (all are given a value factor of 3), while idled land, irrigated pasture, and grassland provide fair forage opportunities (and have a value factor of 2). Those crops and land uses are primarily useful during cultivation, harvest, or undergoing other mechanical disturbance.

Crops such as corn, asparagus, and safflower support few small mammals or are difficult for Swainson’s hawks to penetrate in order to reach prey. But because they are cultivated, and because each may be replaced by other more usable crops on a yearly basis, they have a value factor of 1. Crops/land uses such as orchards, vineyards, rice, have little to no forage value for Swainson’s hawks as they have almost no cultivation associated with them and/or Swainson’s hawk prey are not readily reachable or existing in them; additionally, they are typically long term land uses with little chance that they’ll be converted to more usable field crops; their value factor is ½ . Urban/commercial development, marsh and open water habitats have no forage value now or in the foreseeable future, so it receives a value factor of 0.

The number of acres of each crop type on each island was multiplied by its value factor, and the resulting values were totaled to determine the relative forage value of the available upland habitats for Swainson's hawks. The primary purpose of the exercise was to determine the amount and quality of foraging habitat that would be lost on the reservoir islands, and whether that loss could be mitigated by improving conditions on the habitat islands.

Table 5-8. Swainson's Hawk Foraging Habitat on Webb Tract

Crop	Acres	SWHA value factor	SWHA Forage value
Corn	2744	1	2744
Grain	1920	3	5760
Idle	118	2	236
Native Vegetation	250*	2	500
Total foraging acres	5032	Total forage value	9240

*Approximate value excluding road surfaces and unusable vegetation types that were included in category.

Table 5-9. Swainson's Hawk Foraging Habitat on Bouldin Island

Crop	Acres	SWHA value factor	SWHA Forage value
Corn	3521	1	3521
Grain	1832	3	5496
Native Vegetation	300*	2	600
Total foraging acres	5653	Total forage value	9617

*Approximate value excluding road surfaces and unusable vegetation types that were included in category

Webb Tract has 5032 acres of Swainson's hawk foraging habitat at baseline and a total forage value of 9240 for those acres, which will be lost when the island is flooded. Bouldin Island has a foraging area of 5653 acres, which have a current forage value of 9617. The forage value on Bouldin would have to be increased to 18,857 in order to offset the loss of Webb Tract's acreage. This can be achieved by converting an existing 3100 acres of corn to alfalfa, while leaving all other acreage in baseline condition. Other configurations of crops are also possible, as long as a high percentage of acres are planted to alfalfa.

Table 5-10. Swainson's Hawk Foraging Habitat on Bacon Island

Crop	Acres	SWHA value factor	SWHA Forage value
Corn	2206	1	2206
Sunflowers	872	1	872
Grain	852	3	2556
Potatoes	805	2	1610
Asparagus	290	1	290
Native Vegetation	200*	2	400
Sorghum	71	2	142
Idle	14	2	28
Total foraging acres	5310	Total forage value	8104

* Approximate value excluding road surfaces and unusable vegetation types that were included in category

Table 5-11. Swainson's Hawk Foraging Habitat on Holland Tract (project lands)

Crop	Acres	SWHA value factor	SWHA Forage value
Grain	1230	3	3690
Safflower	993	1	993
Corn	514	1	514
Native Vegetation	100*	2	200
Idle	31	2	62
Total foraging acres	2868	Total forage value	5459

* Approximate value excluding road surfaces and unusable vegetation types that were included in category

Bacon Island has 5310 acres of Swainson's hawk foraging habitat and a forage value of 8104. Holland Tract has 2868 acres of Swainson's hawk foraging habitat with a forage value of 5459. Holland Tract's acreage would have to be improved to a forage value of 13,563 to compensate for the loss of forage on Bacon Island. There is no way to improve the current upland crops to give the mitigation portion of Holland Tract a forage value of 13,563. The maximum that could be achieved is a value of 11,072, and that could only be achieved if 100% of the available cropland listed above were planted in alfalfa; a minimum of 850 acres of off-site cropland with a current value factor of 1 would have to be purchased and put into alfalfa in order to reach the target value of 13,563. In addition, the off-site land would have to be immediately adjacent to Bacon Island and/or Holland Tract to adequately serve the nesting hawks in that area. Because Bouldin Island is 6+ miles from Bacon Island, increasing Bouldin Island's forage value would not serve those Swainson's hawks that lost foraging habitat on Bacon Island.

A number of assumptions are made in this analysis that cannot be completely assured: it assumes that a small area with high forage value is equivalent or better than a large area with moderate forage value; it assumes that energetically, all foraging acreage is equally accessible; it assumes that there will be alternative nest trees in close proximity to the improved but smaller foraging area given that many currently available nest trees on reservoir islands will be lost; and finally, it assumes that condensing the current population in the area to a smaller use area will have no additional detrimental effects. Although these assumptions cannot be assured, current knowledge of the species suggest that this mitigation scenario will indeed offset the negative impacts of the project on foraging habitat. Impacts associated with the loss of nest sites will also have to be addressed, but will likely be appropriately mitigated through the replacement of riparian habitat that will be lost on both reservoir islands, and the affected population will not be reduced due to project activities.

California Black Rail

Although black rails occur within the Delta, they require a minimum habitat size of 10-16 acres of a combination of emergent marsh and associated upland vegetation (Holt and Gifford). Additionally, narrow islands of the proper acreage are not useful, they are susceptible to flooding, and foraging distance for rails increases significantly as foraging range changes from circular to elongate.

No instream islands around the project reservoir islands are large enough to support black rail use. Passive surveys for black rail vocalizations were completed around Bacon Island and no black rails were heard. The impacts to the instream islands from projected facility operations is expected to be nominal. No significant impacts to black rails are expected from the project, and no mitigation should be necessary for the species.

Special-Status Bird Surveys

DWR biologists conducted a total of 70 bird surveys on the In-Delta Storage Project islands from April 2002 to February 2003. Table 5-12 lists the number of surveys conducted on each island by month. Habitat specific surveys were conducted for the western burrowing owl, tricolored blackbird and the loggerhead shrike. Specific surveys were not conducted for other special-status species. However, when one was observed it was recorded.

Table 5-12. Number of Bird Survey Conducted each Month

Month	Webb	Bacon	Bouldin	Holland	Total
April	2	1	2	1	6
May	5	3	2	3	13
June	3	2	2	2	9
July	3	2	3	3	11
August	1	2	2	1	8
September	1	1	1	1	4
October	1	2	1	1	5
November	2	1	2	1	6
December	1	0	0	1	2
January	1	1	1	1	4
February	1	1	1	1	4
Total	**21**	**16**	**17**	**16**	**70**

Western Burrowing Owl

The western burrowing owl (*Athene cunicularia hypugaea*) is a California species of special concern because of declines in suitable habitat and declines in local and statewide populations. Burrowing owls are found in open, dry grasslands, agricultural and range lands, and desert habitats often associated with burrowing animals. They can be found at elevations ranging from 200 feet below sea level to 9,000 feet. The owl commonly perches on fence posts or on top of mounds outside its burrow. They are active day and night, but are usually less active in the peak of the day.

In addition to the presence of burrows, burrowing owl habitat suitability in the Central Valley is based on percent vegetation cover, height of vegetation surrounding the burrow, the presence of ground squirrels, soil texture, and the presence of perches. Burrowing owls nest in burrows in the ground, often in old ground squirrel burrows. They can dig their own burrows, but prefer deserted excavations of other animals. They are also known to use artificial burrows.

Owl nesting season begins in late March or April. Burrowing owls may use a site for breeding, wintering, foraging, and/or migration stopovers. Occupancy of suitable burrowing owl habitat can be verified by an observation of at least one burrowing owl, or, alternatively, its molted feathers, cast pellets, prey remains, eggshell fragments, or excrement at or near a burrow entrance. Burrowing owls exhibit high site fidelity, reusing burrows year after year (Trulio 2000).

Methods

We conducted habitat specific surveys for burrowing owls by driving island roads and walking through areas of potential owl habitat. We investigated specific habitat components for the presence of owls by searching for burrows. We monitored areas with burrows during each survey for signs of owl feathers, pellets, prey remains, eggshell or excrement at or near the burrow entrance.

Results and Discussion

Potential nesting and wintering habitat for the western burrowing owls exist on the project islands. However, California ground squirrel burrows are extensive along the interior side of the levees on Holland Tract and Bacon Island. These burrow locations are not ideal for burrowing owls as they are on exposed levee slopes in which vegetation is intensely managed. There were no burrowing owls observed during any of the bird surveys conducted during 2002-03. There were no signs of burrowing owls using abandoned ground squirrel burrows on Holland Tract or Bacon Island during nesting and wintering periods. There were no burrowing owls observed using artificial burrows (i.e. abandoned pipes and culverts) on any of the project islands during the nesting and wintering periods.

Levee vegetation management was intensive on Holland and Bacon in 2002. Levee maintenance activities included discing and grazing, which altered habitat conditions by damaging burrows. JSA biologists observed one burrowing owl on Bacon Island in 1988.

Potential Impacts

Based upon the 2002-2003 surveys there would be no direct loss of burrowing owls. Nevertheless, potential suitable habitat for burrowing owls would be lost on Webb Tract and Bacon Island from flooding the islands. Based upon the 1996 DWR Land Use Data approximately 633 acres of native vegetation would be lost on the reservoir islands. The revised HMP provides for high quality grassland habitat (herbaceous uplands) on the habitat islands, which would compensate for the loss of low-quality levee grassland habitat on the reservoir islands.

Tricolored Blackbird

The tricolored blackbird (*Agelaius tricolor*) is a federal species of concern and a California species of special concern. Predation, habitat loss and alterations, poisoning, contaminants, and human disturbances threaten populations.

Tricolored blackbirds have three basic requirements for breeding colony sites: (1) open accessible water; (2) protected nesting substrate, which is usually either flooded or thorny or spiny vegetation; and (3) suitable foraging space providing adequate insect prey within a few kilometers (km) of the nesting colony.

Tricolored blackbirds predominately nest in freshwater marshes dominated by bulrushes *(Scirpus* sp.) and cattails *(Typha* sp.). The remaining colonies nest in willows *(Salix* spp.), blackberries *(Rubus* sp.), thistles *(Cirsium* and *Centaurea* spp.), or nettles *(Urtica* sp.). An increasing percentage of tricolored blackbird colonies in the 1980s and 1990s were reported in Himalayan blackberries *(Rubus discolor)*, and some of the largest recent colonies are in silage and grain fields. Other substrates where tricolors have been observed nesting include giant cane *(Arundo donax),* safflower *(Carthamus tinctorius),* tamarisk trees *(Tamarix* spp.), and poison oak *(Toxicodendron diversilobum).* In addition, they have been found in habitats that include riparian scrublands (e.g., *Salix, Populus, Fraxinus)* and forests.

Tricolored blackbird foraging habitats include pastures, dry seasonal pools, agricultural fields (such as alfalfa), rice fields, feedlots, and dairies. Tricolors also forage occasionally in riparian scrub, saltbush scrub, marsh borders, and grassland habitats. Weed free row crops and intensively managed orchards and vineyards do not serve as regular foraging sites. Nestlings are mainly fed insects. Adults may continue to consume plant foods throughout the nesting cycle but also forage on insects and other animal foods. Tricolors feed primarily on grains during the winter. This includes rice, other grains, and weed seeds. In winter, tricolors often form mixed flocks with other blackbirds. Flocks as large as 15,000 individuals form and then disperse to foraging sites. Some winter foraging flocks are composed almost entirely of one sex (Beeby and Hamilton 1997).

Survey Objectives

- Determine if any tricolored blackbird nesting colonies are present on the project islands
- Determine if tricolors forage on the project islands

Methods

DWR staff conducted surveys from April through September 2002 to determine if any tricolored blackbird nesting colonies were present on the project islands. Staff conducted habitat specific surveys by monitoring suitable nesting habitats for the presence of tricolored blackbird nesting colonies on all project islands. DWR staff searched for tricolored blackbirds by driving or walking to about 100-feet from potential nesting habitat and listening for calls and observing birds with binoculars and a spotting scope. Staff made observations from behind vegetation or a vehicle, as much as possible. DWR staff also surveyed for foraging male tricolored blackbird flocks by driving along levee and farm roads adjacent to grasslands and grain crops and periodically stopping to scan the area with binoculars and a spotting scope.

DWR staff conducted surveys from October 2002 through February 2003 to determine if any tricolored blackbirds were foraging on the project islands during the winter. Staff monitored winter flocks of blackbirds with binoculars and spotting scope to determine the presence of tricolored blackbirds. When tricolors were observed, the number of tricolored blackbirds in wintering flocks were estimated, the habitat types were recorded and the location was noted on a map.

Results and Discussion

Potential nesting habitat was present on all project islands in 2002 and consisted of emergent marsh, willow scrub, riparian woodlands, Himalayan blackberry brambles, and grain crops. Nesting colonies were not detected on any of the project islands during the 2002 field surveys.

Foraging habitat on the project islands included grainfields, sunflowers, and safflower. Tricolored blackbirds were not observed foraging on the project islands during the spring and summer. Despite the amount of foraging habitat, tricolors were only detected on a few occasions foraging on Bacon Island and Webb Tract during the fall and winter. Tricolored blackbirds were detected foraging in mixed flocks of blackbirds most often. In addition to tricolored blackbird, the mixed flocks usually included red-winged blackbirds, European starlings, and yellow-headed blackbirds. Tricolored blackbirds were not observed during the 1988 surveys for the Delta Wetlands Project.

I first observed tricolored blackbirds foraging for invertebrates in the soil of a wet harvested field on the northeastern section of Bacon Island in early October 2002. Tricolors were first observed in early October 2002 on the northeastern section of Bacon Island foraging for invertebrates in the soil of a wet harvested field. I detected large flocks of mixed blackbirds foraging in recently harvested sunflower fields in mid-October 2002. The mixed flocks included thousands of individuals and moved continuously, which made it difficult to estimate the number of tricolors. I observed approximately 200-300 tricolors foraging on the soil surface. I also observed a flock of about 50 male tricolors flying back and forth from the sunflower fields to bulrushes growing on the riverside of the levee on the east side of Bacon. I observed tricolors along the northwestern side of Bacon in November 2002, January and February 2003. Tricolors were with mixed flocks foraging in harvested sunflower fields and cornfields during every observation on the northwestern side of Bacon Island. Occasionally a few to several individuals of the mixed flock would fly to the bulrushes and trees on the riverside of the levee to rest for a few minutes then fly back to the fields to forage.

In January and February 2003, I observed tricolored blackbirds on the south side of Webb Tract foraging in harvested cornfields. An estimated 20-30 tricolored blackbirds were in a mixed flock of about 200-300 blackbirds. I observed tricolors only on the south side of Webb Tract on two occasions despite the uniformity of habitat types throughout the island.

Potential Impacts

DWR staff did not observe tricolors foraging on the habitat islands during the 2002-2003 surveys. However, large flocks of foraging blackbirds were observed on Bouldin Islands and Holland Tract. Since tricolors were observed on Webb and Bacon, it is likely that they also occurred on Bouldin Island because of the similar crop types. Crops were not planted on Holland Tract during 2002, so grains were not available for foraging during the winter.

The size of the foraging area for tricolored blackbirds is dependent upon the unpredictable abundance of insects from the nesting location. Although no nesting colonies or foraging tricolors were observed during the spring and summer, impacts may occur under some conditions, since the foraging radius can be up to eight miles from the nesting location (Cook 2002, personal communication; See "Notes"). Additionally, flooding the reservoir islands will result in the loss of potential winter foraging habitat for the tricolored blackbirds. The amount of potential habitat lost will be variable and be dependent upon the amount and type of crops that are planted and the farming practices that are implemented after harvesting (e.g. tilling and clearing fields of waste material or flooding). Based upon the 2002-2003 surveys, impacts to tricolors from flooding Webb Tract will be minimal because a relatively small number of tricolors foraged on the island. The potential impact on tricolored blackbirds from flooding Bacon Island could be substantial. Flocks with thousands of individual blackbirds were observed on Bacon Island during and immediately after sunflower harvest. Also, tricolors foraged on Bacon Island through the entire winter.

Levee improvements will probably eliminate vegetation growing along the outside levees where tricolored blackbirds were observed resting. This impact will be minimal because it is unlikely that tricolors will use the narrow strips of vegetation if there is no adjacent foraging habitat.

The high-quality diverse habitat types including grains, grasslands, alfalfa and nesting substrates that are proposed in the revised HMP should compensate for the loss of tricolored blackbird habitat on the reservoir islands.

Loggerhead Shrike

The loggerhead shrike (*Lanus ludovicianus)* is a federal species of concern and a California species of special concern. Loggerhead shrikes require open grassland or agricultural areas with scattered shrubs or small trees for perching, hunting, and nesting. Nesting shrubs and trees can be loosely scattered, arranged in a linear or grid fashion, or isolated. Typical habitats include fallow fields and other idle grassland fields, pastures, open savannas, farmsteads, parks, golf courses, cemeteries, and roadsides with shrubs, saplings, and small trees. Shrikes also use areas of open cropland with adjacent hedgerows, fences, shrubs, or saplings. They frequently use utility wires for perching. Shrikes require at least one shrub, sapling, or small tree, typically with dense foliage, for perching, hunting, and nesting. Thorny or spiny shrubs and trees are preferred as they can be used for impaling prey; barbed wire fences are also used for this purpose. Shrikes tend to prefer habitats with grasses and forbs of relatively short to medium height and some bare ground for hunting (Yosef 1996).

Methods

DWR staff conducted habitat specific surveys for loggerhead shrike on the In-Delta Storage Project islands by driving and walking on levee and main roads adjacent to loggerhead shrike habitats. Staff searched herbaceous and riparian habitats and monitored with binoculars and a spotting scope to determine the presence of loggerhead shrike. Staff recorded the number of shrikes observed and mapped and numbered observation locations.

Results and Discussion

DWR staff observed shrikes on all In-Delta Storage Project islands through the spring, summer, fall and winter (Figure 5-18). DWR staff did not observe any shrikes in April 2002 on any of the In-Delta Storage Project islands. The primary loggerhead shrike habitat on the project islands is on interior levees that contain utility lines or fences. Loggerhead shrikes were observed only in areas with above ground utility lines located near levees on Webb Tract, Bouldin Island and Bacon Island. Shrikes perch on the utility lines to locate prey on the ground. Shrikes generally move up and down the levees hunting for prey.

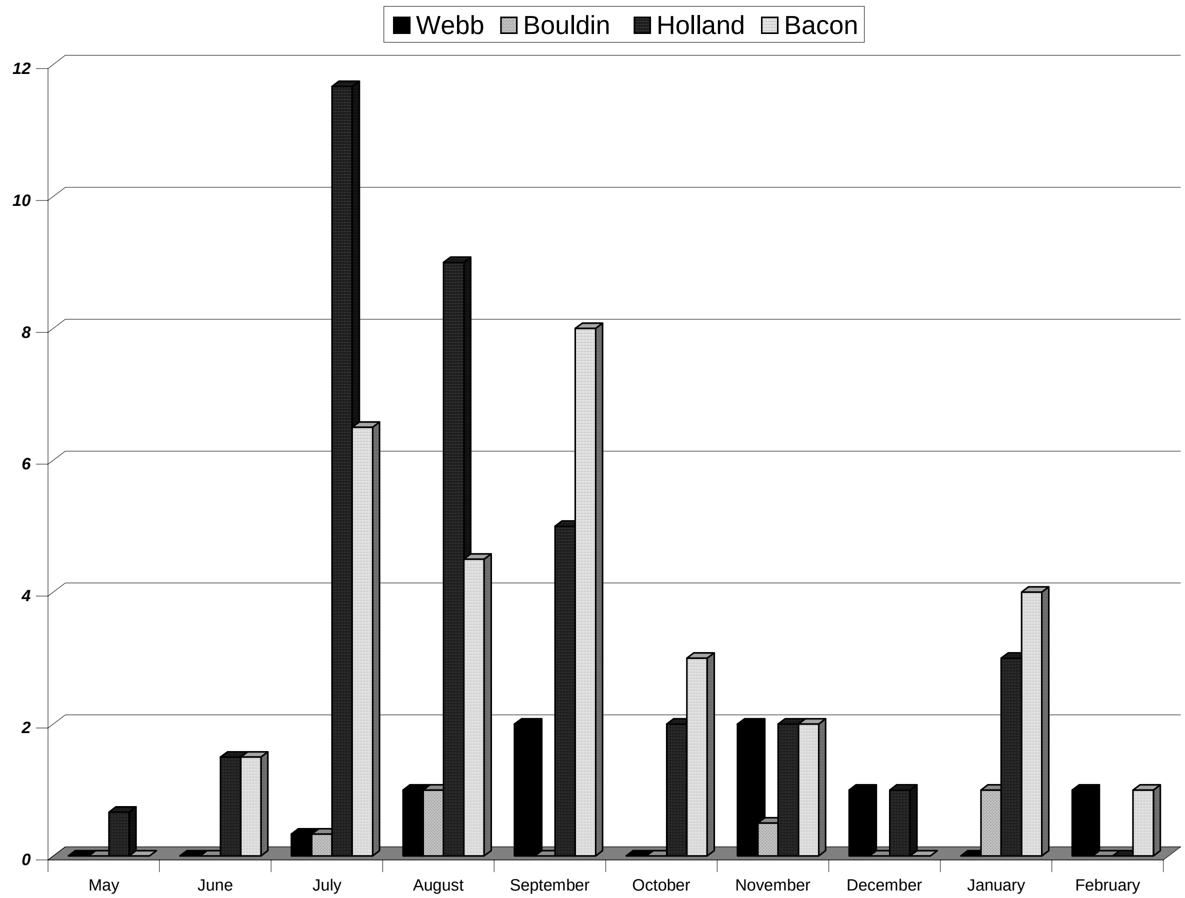
Holland Tract's pasture (with fences and utility lines), riparian habitat, rows of trees and blackberry shrubs provide foraging and nesting habitat across the island. Shrikes were observed during the entire survey period on Holland. DWR staff observed the highest monthly average of shrikes (11.7) and the highest number (19) in July on Holland Tract. Staff conducted only one survey each month on Holland Tract from August 2002 to February 2003. The number of shrikes declined on Holland starting in August and continued through December. The number of shrikes seen in January 2003 was slightly higher than in December 2002. During the February 2003 survey, access was limited to the levee road because sandhill cranes were foraging across the island.

Utility lines are located at the base of the levees around Bacon Island. Shrikes were observed on the levees around the entire island, except in developed areas, such as houses and warehouses. DWR staff observed the highest number of shrikes in July, August, and September on Bacon Island. The number of shrikes dropped in October and remained low through February 2003. There are suitable nesting trees located intermittently around Bacon Island.

There was a difference in the number of shrikes that used the southern islands compared to the northern islands. Ninety percent of the loggerhead shrikes observed on the In-Delta Storage Project islands occurred on Holland Tract and Bacon Island. DWR staff counted only eight shrikes during 6 different surveys on Webb Tract. Also, DWR staff observed only five shrikes on 4 different surveys on Bouldin Island. Staff did not observe more than two shrikes per survey for both Webb Tract and Bouldin Island. Utility lines are located at the base of levees on Webb Tract, as on Bacon Island, however the number of shrikes observed was much lower. On Bouldin Island the above ground utility lines are located mostly along the northern and western levees.

JSA biologist observed loggerhead shrikes only on Webb Tract during the 1988 surveys for the Delta Wetlands Project. JSA biologist observed an average of 3.5 shrikes (n=5) per survey during four surveys in February and one survey in March 1988 on Webb Tract. DWR staff observed an average of 4.3 (n=16) shrikes per survey on Holland Tact, 2.9 (n=16) on Bacon Island, 0.4 (n=21) on Webb Tract, and 0.3 (n=17) on Bouldin Island from April 2002 to February 2003.

Figure 5-18. Average Number of Loggerhead Shrikes Observed Per Month on In-Delta Storage Project Islands, May 2002 - February 2003



Potential Impacts

Potential impact to the loggerhead shrike foraging habitat would occur from flooding Bacon Island and Webb Tract. Based upon the 1996 DWR Land Use Data approximately 633 acres of native vegetation would be lost on the reservoir islands. In addition, foraging habitat for the loggerhead shrike would be lost on Holland Tract by converting pastures to wetlands and crops under the revised HMP. The revised HMP will provide high quality grassland habitat (herbaceous uplands) and preserve shrubs and scattered trees on the habitat islands. This will compensate for the loss of low-quality levee grassland habitat on the reservoir islands and pasture on Holland Tract.

Other Special-Status Species

DWR staff periodically observed other special-status bird species when conducting the bird surveys described in the previous sections. Staff did not conduct specific surveys for these species, therefore, survey data are not provided. The list of species seen by Project Island is provided in Table 5-13.

Table 5-13. Special-Statues Bird Species Incidentally Observed on In-Delta Storage Project Islands 2002-2003

Species	Status	Webb	Bacon	Bouldin	Holland
American peregrine falcon	SE	X	X	X	X
American white pelican	CSC	X	X	X	X
California Gull	CSC	X	X	X	X
California horned lark	CSC	X		X	
Cooper's Hawk	CSC	X	X	X	X
Ferruginous Hawk	CSC				X
Northern Harrier	CSC	X	X	X	X
Osprey	CSC	X			X
Rough-legged hawk	FSC/CSC	X			
Sharp-shinned Hawk	CSC			X	
White-tailed kite	FSC	X	X	X	X
Yellow warbler	CSC	X			

SE=State Endangered, CSC=California species of special concern, FSC=federal species of concern

JSA biologist observed all the species presented in Table 5-13 during the 1988 surveys for the Delta Wetlands Project with the exception of the American peregrine falcon, the ferruginous hawk, osprey and the yellow warbler. DWR staff periodically observed the peregrine falcon on the project islands during the winter 2002-2003. Staff observed ospreys during three surveys on Webb Tract and two surveys on Holland Tract in 2002-2003. DWR staff observed the ferruginous hawk one time on Holland Tract during the winter 2003. Staff observed the yellow warbler once in early spring 2002 in riparian woodlands next to a blowout pond on Webb Tract.

The development of a mosaic of diverse habitat types that include wetlands, riparian, grasslands and crops proposed in the revised HMP on the habitat islands would mitigate for the impacts to special-status species.

Bats

DWR staff identified three species of bats as potentially occurring on the In-Delta Storage Project islands in the 2002 Planning Study Report (CALFED 2002). Bat surveys were not done for the 1995 DIER/EIS for the DW Project. DWR staff recommended a bat habitat evaluation be completed for the project islands (CALFED 2002) and the evaluation was completed in late 2002.

The evaluation found that suitable roosting habitat is present on each island in crevices, cavities and foliage found in vegetation and structures. Accessible structures were visually inspected and no roost sites were found. Foraging habitat is present on each island and acoustic surveys at selected sites detected bat activity near water features, riparian vegetation, and open pasture on Bacon Island and Holland Tract. No bats were detected on a single night's survey on Bouldin Island during unfavorable weather. Webb Tract was not surveyed for bat foraging because of access restrictions. Important habitat components were identified including riparian woodlands, lakes and ponds, irrigation canals lined with vegetation, and open pasture with complex vegetation interfaces. Habitat will be lost on Webb Tract and Bacon Island and recommendations are made in the technical memorandum to create or expand important habitat components on Holland and Bouldin islands. Additional focal species surveys were recommended for Webb Tract and Holland Tract because potential habitat is present but preliminary surveys were insufficient to address the presence of specific species. If presence is assumed mitigation in kind (1:1) should be sufficient.

The technical memorandum describing the methods and complete results of the evaluation is included in Appendix C.

Mitigation Requirements and Strategies

The 1995 Draft HMP for the Delta Wetlands Project compensates for the impacts to species and habitats that were identified and assessed in the late 1980's. The 1995 HMP is a living document and allows for adjustments based on species and habitat needs. The 1995 HMP does not provide species specific compensation goal and objectives for the giant garter snake because it was determined that effects on it would be insignificant (USFWS 1997a). Habitat for the Swainson’s hawk and the greater sandhill crane has increased on the project islands since 1988. Therefore, as part of the planning process, DWR has developed a revised HMP to compensate for the loss of giant garter snake habitat, greater sandhill crane habitat, Swainson's hawk habitat and jurisdictional wetlands. It is necessary to identify the mitigation that is likely to be required for the project in order to assess the costs and feasibility of the project. The revised HMP is based on the assumption that giant garter snakes are present on the project islands.

The revised HMP would mitigate all impacts to jurisdictional wetlands, giant garter snake, greater sandhill crane and Swainson's hawk nesting habitat and a portion of Swainson's hawk foraging habitat impacts on Bouldin Island and Holland Tract. DWR and Reclamation would acquire conservation easements for any remaining Swainson's hawk foraging habitat mitigation. Implementing the revised HMP will also mitigate for the loss of habitat for other special-status species.

During the subsequent EIR/EIS process additional work will be done to refine the revised HMP to insure that the needs of all listed species are met. The version of the HMP that is ultimately selected will be based on a number of factors, including the results of the giant garter snake presence/absence surveys, input from the resource agencies, the federal and state ESA consultation process, the NEPA/CEQA process, stakeholder review and costs.

Potential Giant Garter Snake Habitat Mitigation

Approximately 458 acres of potential giant garter snake (GGS) habitat on Bacon Island and 657 acres of potential GGS habitat on Webb Tract will be lost if these islands are flooded. At 3:1, 3,345 acres of mitigation will be required on Bouldin Island and Holland Tract (habitat islands). Approximately 2 acres of suitable upland should either be preserved or created for every

1 acre of suitable aquatic habitat preserved or created on the habitat islands. All potential GGS habitat on the habitat islands will either be preserved or improved so no mitigation for impacts to this habitat will have to be provided.

DWR is investigatinf the presence or absence of giant garter snakes on the reservoir islands in 2003 and 2004. The results of this investigation will determine the extent of the actual mitigation required. If the investigation is done to satisfaction of USFWS and DFG and it is determined that giant garter snakes are not present on the project islands no mitigation would be required.

Conducting baseline surveys on the habitat islands is dependent on the results from the reservoir island surveys and input from USFWS and DFG. DWR and Reclamation will consult with the agencies on the management practices that will be used on the habitat island to insure that take is minimized if the islands are colonized by GGS in the future.

Jurisdictional Wetland Mitigation

Table 5-15 depicts jurisdictional wetland habitat types that would have been impacted by the 1995 HMP and the mitigation required under the Department of the Army Permit 190109804 (DA Permit). Jurisdictional wetland habitat types that can function as suitable upland GGS habitat if managed properly are cottonwood willow woodland and great valley willow scrub. Jurisdictional wetland habitat types that can function as suitable aquatic GGS habitat if managed properly are freshwater marsh and permanent pond. Impacts to exotic marsh will be mitigated with creation or preservation of emergent marsh.

Table 5-15. Jurisdictional Wetlands Impacts and Mitigation Requirements According to DA Permit 190109804

Habitat Type	Reservoir Islands (acres)	Habitat Islands (acres)	Total Impacts (acres)	Mitigation Ratio	Required Mitigation (acres)
Cottonwood Willow Woodland	100.4	6.5	106.9	3:1	320.6
Great Valley Willow Scrub	65.9	10.2	76.1	2:1	152.1
Exotic Marsh	102.2	44.7	146.9	2:1	293.7
Freshwater Marsh	70.3	85.1	155.4	2:1	310.8
Permanent Pond	84.7	0	84.7	1:1	84.7

Some of these habitat types currently exist in places that were identified as potential GGS habitat during the habitat evaluations in 2002, and others are located in areas that can be easily avoided during implementation of the revised HMP. Using ArcView 8.2, I calculated the areas of jurisdictional wetland habitat types that did not overlap with any potential GGS habitat and that could possibly change to non-wetland habitat types during implementation of the revised HMP. Table 5-16 depicts the estimates of impact on Bouldin Island and Holland Tract in addition to the impacts on the reservoir islands. It also reports the potential mitigation requirements using the same mitigation ratios as those found in the DA Permit.

Implementing the revised HMP is not expected to impact the remaining acreage of jurisdictional wetlands on the habitat islands. These areas will be incorporated into the design of the new HMP along with the potential mitigation requirements listed in Table 5-16. Table 5-17 depicts the acreage of existing jurisdictional wetland types that are expected to remain under the revised HMP and the amounts of each habitat type that must be provided to meet the potential mitigation requirements.

Table 5-16. Estimated Impacts to Jurisdictional Wetlands on Habitat Islands and Potential Mitigation Requirements under New HMP

Habitat Type	Bouldin Island (acres)	Holland Tract (acres)	Habitat Islands Total (acres)	Reservoir Islands Total (acres)	Potential Mitigation (acres)
Cottonwood Willow Woodland	0	0	0	100.4	301.2
Great Valley Willow Scrub	0	1.8	1.8	65.9	135.4
Exotic Marsh	6.1	36.2	42.3	102.2	291.0*
Freshwater Marsh	12.6	2.6	15.2	70.3	171.0
Permanent Pond	0	0	0	84.7	84.7

* Mitigated as Freshwater Marsh

Table 5-17. Jurisdictional Wetlands Remaining on Habitat Islands and Additional Mitigation Requirement

Habitat Type	Bouldin Island (acres)	Holland Tract (acres)	Total Remaining (acres)	Potential Mitigation (acres)	Total Required in New HMP (acres)
Cottonwood Willow Woodland	2.0	75.0	77.0	301.2	378.2
Great Valley Willow Scrub	7.5	6.0	13.5	135.4	148.9
Exotic Marsh	32.2	24.3	56.5	0	56.5
Freshwater Marsh	57.9	56.4	114.3	462.0	576.3
Permanent Pond	1.0	9.8	10.8	84.7	95.5

Revised Habitat Management Plan

Because some of the jurisdictional wetland habitat types are consistent with GGS habitat, the revised HMP can be designed to accommodate the mitigation requirements for both. Table 5-18 depicts the minimum habitat types and acreages required to mitigate impacts to potential GGS habitat and jurisdictional wetlands. Additional habitat types are included to mitigate for the impacts to the greater sandhill crane and Swainson's hawk. DWR would have to acquire conservation easements offsite to fully mitigate for the impacts to Swainson's hawks.

Table 5-18. Revised HMP Mitigation Strategy

Habitat Type	Bouldin Island (acres)	Holland Tract (acres)	Total (acres)
Suitable Upland GGS Habitat	***1396.0***	***834.0***	***2230.0***
Cottonwood Willow Woodland	190.6	187.6	378.2
Great Valley Willow Scrub	92.3	56.6	148.9
Herbaceous Upland	947.7	540.7	1488.4
Canal (Upland Component)	165.4	49.1	214.5
Suitable Aquatic GGS Habitat	***698.0***	***417.0***	***1115.0***
Emergent Marsh	543.3	378.0	921.3
Permanent Pond	85.7	9.8	95.5
Canal (Aquatic Component)	69.0	29.2	98.2
Total Suitable GGS Habitat	***2094.0***	***1251.0***	***3345.0***
Unsuitable Habitat for GGS	***3932.0***	***1840.0***	***5772.0***
Other crops(harvested)	350.0	170.0	520.0
Corn (unharvested)	339.2	105.7	444.9
Wheat (unharvested)	1225.0	595.0	1820.0
Alfalfa	1925.0	935.0	2860.0
Developed	92.8	34.3	127.1

Greater Sandhill Crane Mitigation

DFG has not established specific requirements or guidelines for assessing or mitigating impacts on the greater sandhill crane. DWR proposes to mitigate impacts of the In-Delta Storage Project on wintering greater sandhill cranes by providing diverse habitat assemblages. Habitat components would fulfill the survival needs of wintering cranes and provide calories to store for spring migration. Essential habitats that DWR would provide include:

∉ Corn and wheat crops for acquiring sufficient carbohydrates,

∉ Grasslands and alfalfa for obtaining protein, calcium, and other essential nutrients, and

∉ Seasonal wetlands (flooded agricultural and fallow fields) for protected roosting and loafing sites and for obtaining protein.

A total of 10,647 acres of mostly harvested crops and roosting habitat would be lost from flooding the reservoir islands and from developing unsuitable crane habitat types on the habitat islands. Under the revised HMP, about 6,613 acres of foraging and roosting habitat would be developed on Bouldin Island and Holland Tract (Table 5-19). DWR would purchase conservation easement of approximately 3,900 acres for Swainson's hawk mitigation, which may convert corn to harvested alfalfa and wheat. Approximately 900,000 pounds of corn would be available for forage, which is about 400,000 less than the amount that would be lost (1,280,123.) on the project islands. There would be approximately 4.5 million pounds of wheat available for forage, which is more than 21 times the amount of wheat that would be lost (209,976). Overall there would be over 5.4 million pounds of grain available for forage, which is over three times the amount of grain that would be lost on the project islands. If all 3,900 acres of the conservation easements acquired for Swainson's hawks would result in corn being converted to alfalfa, wheat and other crops; about 600,000 pounds of grains available for forage would be lost on adjacent islands.

Table 5-19. Revised HMP Habitats Suitable for Greater Sandhill Crane

Habitat Type	Bouldin Island (acres)	Holland Tract (acres)	Total (acres)	Pounds of Forage
Corn (unharvested)	339.2	105.7	444.9	889,800
Wheat (unharvested)	1225.0	595.0	1820.0	4,550,000*
Herbaceous Upland	947.7	540.7	1488.4	
Alfalfa	1925.0	935.0	1894.9	
Suitable greater sandhill crane habitat	***3436.9***	***2176.4***	***5613.3***	***5,439,800***

* This estimate assumes that up to half the wheatfields will be flooded for roosting/loafing habitat

Greater Sandhill Crane Habitats

The habitat design and management recommendations provided below are based upon the recommendations provided by Littlefield and Ivey (2000) for the Cosumnes River Floodplain and the Delta regions of California.

Seasonal Wetlands (flooded agriculture and fallow fields)

Seasonal Wetlands should be managed at an early seral vegetation stage, with flooding during the wet season (November through April). Some wetlands (roost sites), however, should be flooded by early September for cranes that arrive in early fall. Dense stands of emergent vegetation or other heavy cover should be removed, as cranes tend to avoid these wetlands. Seasonal wetland design and management should include the following:

- Seasonal wetlands should be widely dispersed and be maintained with flowing water to reduce potential for disease outbreaks.
- Wetlands should be designed with sloping banks which allow cranes to walk onto the site from adjacent uplands

∉ Seasonal wetlands should be at least 8 ha (20 acres) in size; wetlands 40 ha (100 acres) or more is preferred to provide additional security and benefit to cranes and to a variety of other wetland species

∉ Water levels should be managed to provide extensive areas at depths ranging from 8-20 cm (3-8 inches).

∉ A portion of the seasonal wetlands should be in a seasonal wetlands-to-agriculture rotation. After two years the seasonal wetlands is planted in wheat for four years. Seasonal wetlands provide habitat to additional wildlife species and are preferred by cranes. Also, the vegetation grown in the wetlands over two years may reduce the loss of organic soils from oxidation. The percentage of this habitat will be determined during consultation with regulatory agencies.

∉ Small gravels should be spread along roads, bare shoreline areas or on islands to provide grit sources for cranes

∉ Seasonal wetlands should be positioned at least 0.1 km (0.25 mile) from heavy traffic; areas open to hunting, or other disturbing uses. If hunting occurs in roost sites, than it should be limited to mornings before 10 am, before cranes return to wetlands for loafing.

Corn and Wheat Fields

∉ Corn and wheat fields should be managed to provide an abundance of food that persists through the winter period. Unharvested grain fields should be a minimum of 8-12 ha (20 - 30 acres).

∉ A percentage of the unharvested cornfields should be left standing into March. The percentage of the corn to be left standing will be determined during consultation with the regulatory agencies.

∉ Winter wheat can provide multiple benefits to cranes. Flooding harvested fields for preirrigation of the next crop in September provides wetland roost areas, and wheat fields planted in succession in late fall and early winter provide a sustained source of grain and new green sprouts for cranes foraging through most of the winter period.

Herbaceous Upland

∉ Herbaceous uplands should be managed to provide vegetation that does not exceed 25 cm (10 inches).

∉ Sides of levees should be managed for short vegetation. Cranes frequently feed and loaf on levees during the daytime.

∉ Graze 20 -40 % of grasslands with cattle or burn in the autumn to provide green plant foods for crane foraging, if compatible with other sensitive species.

Other Mitigation Options for Greater Sandhill Crane

If all greater sandhill crane mitigation requirements can not be physically located on Bouldin Island and Holland Tract, then DWR should explore the possibility of providing funds to improve or develop crane roosting habitats on Staten Island.

Swainson's Hawk Mitigation

Effects of added Giant Garter Snake Mitigation Habitat on available Swainson's Hawk Habitat

If giant garter snakes are determined to occur on the reservoir islands at the maximum potential identified by Hansen and Patterson, and the amount GGS/wetland habitat on Bouldin Island is increased to approximately 2100 acres (as per revised HMP developed by DWR), acreage for upland crops will be reduced to approximately 3800 acres. Corn for cranes will be planted on 300 acres, and 3500 acres will be available for an high value Swainson's hawk crop mix (alfalfa and wheat in rotation with other suitable crops/fallowed fields at a recommended 55-35-10 division, respectively). The target Swainson's hawk forage value for Bouldin Island is about 18,900. If all 3500 acres of remaining cropland were grown in the high value mix, Bouldin's total foraging value would be 14,000. An additional 1650 acres of value 1 cropland would have to be purchased and grown to the high value mix to fully mitigate the loss of Swainson's hawk foraging habitat on both Webb Tract and Bouldin Island.

Up to 1250 acres of GGS/wetland habitat will be added to Holland Tract to account for the loss of GGS habitat and wetlands on Bacon Island, as per revised HMP. This and the 100 acres of crane feed plots will reduce available Swainson's hawk foraging habitat on Holland Tract to 1700 acres. The target Swainson's hawk forage value for Holland Tract is about 13,600. If all available crop acres are grown in high value Swainson's hawk mix, Holland Tract would reach a forage value of 6800, requiring that an additional 2250 acres of value 1 cropland would have to be purchased and managed in the high value foraging habitat mix. All totaled, DWR would have to purchase an additional 3900 acres of value 1 cropland and convert the crop to the high value mix.

Integrating the 1995 HMP with Swainson's hawk mitigation needs

The ratio of habitat types developed for the two habitat islands in the 1995 Delta Wetlands Habitat Management Plan would further reduce the available Swainson's hawk foraging area on both Bouldin Island and Holland Tract. The HMP ratios would result in a maximum of just 2881 acres and 1810 acres, respectively, or just 25% of the original Swainson's hawk foraging habitat that (currently) exists on the project islands.

Given that DWR would have to purchase an additional 3500 acres of upland crop habitat to offset impacts to Swainson's hawks and giant garter snakes, it is likely that all non-crop habitat types listed in the HMP may be maintained in gross acreage. In addition, it is likely that the combination of wheat and alfalfa, managed appropriately for Swainson's hawks during their nesting period, could be managed appropriately for waterfowl, sandhill cranes, and other wildlife species during winter periods. So although the HMP in its current form (specific land uses and ratios) would not be compatible with mitigation ratios needed to sustain Swainson's hawks at current level on project islands, it would only need minor modifications to meet the listed species needs and the original goals of the document.

Integrating Swainson's Hawk Mitigation with Sandhill Crane Mitigation

The revised HMP ratios developed for GGS and Sandhill Crane (SACR) indicate that GGS habitats will account for about 2100 acres on Bouldin and 1250 acres on Holland. Since these habitats have little or no forage value for Swainson's hawks, about 3800 and 1800 acres of cropland exists to be managed for SWHAs and SACR on Bouldin and Holland, respectively.

The recommended crop ratios to mitigate lost Swainson's hawk habitat on the remaining cropland is 60% alfalfa and 40% wheat, with 10% of all cropland rotated to other usable crops/vegetation to keep soils healthy. According to information provided by Gary Ivey, sandhill cranes prefer wheat to other grains, so sandhill crane habitat and Swainson's hawk habitat are almost completely compatible with specific management regimes; those include leaving wheat unharvested and rotating some agricultural lands into “seasonal wetlands” by flooding fallowed fields. The loss of potential roost sites on Webb and Bacon will be mitigated by the wetted fallowed fields and by shallow-flooding other cropland in appropriate amounts.

Ivey also recommends small feed-plots of unharvested corn approximately 30 acres in size. Such feed plots totaling 150 acres can support thousands of cranes with necessary carbohydrates for migration; that would more than cover the current use by cranes on the islands. Each island should include six- 30 acre feed plots in close proximity to fields designated for roosting. This would reduce Swainson’s hawk-compatible forage crops to approximately 3500 and 1700 acres on Bouldin and Holland, respectively.

If the remaining 3500 acres of available cropland on Bouldin are grown to alfalfa and wheat at the above ratio with a 10% yearly rotation of those crops to other Swainson’s hawk-usable crops and flooded fallowed fields, about 1650 offsite acres would have to be obtained under easement to provide essentially the same forage value that Bouldin and Webb have at baseline. A percentage of the unharvested wheat should be "knocked down" to create an edge effect to increase accessibility to prey for Swainson's hawks

If the remaining 1700 acres of available cropland on Holland are grown to the recommended Swainson’s hawk-compatible crop ratio, an additional 2250 acres would have to be obtained offsite through conservation easement to achieve a similar forage value contained by both Holland and Bacon at baseline. The amount of offsite habitat obtained by easement for both reservoir islands would be reduced should the amount of wetland mitigation be reduced, and additional cropland on the habitat islands became available for cranes and Swainson’s hawks.

Sandhill Crane Needs

Information provided by Gary Ivey in a personal communication and in a report on conservation for sandhill cranes indicates that almost all habitat provided for Swainson’s hawk mitigation for the project can be managed for crane habitat as well. Wheat is the crane’s preferred grain forage, and alfalfa is forage habitat for high protein invertebrates. Roost sites can be provided by flooding cropland and fallowed fields, and would be equivalent to those lost on the reservoir islands. Plots of unharvested corn will provide late season forage for cranes. Refer to the greater sandhill crane section for information on habitat needs.

Other Mitigation Options Considered

During the public review of the 2002 Draft In-Delta Storage Program Environmental Evaluations Report DWR was requested to evaluate the possibility of mitigating for wildlife impacts on Sherman Island and Twitchell Island and leaving Bouldin Island in agriculture. The CALFED ROD has committed to restoring habitats on Sherman Island and Twitchell Island through the Ecosystem Restoration Program (ERP). The ERP has committed to restoring nontidal perennial aquatic habitat, freshwater emergent wetland habitat (nontidal), and seasonal wetland habitat on Sherman Island and Twitchell Island (CALFED 2000). Since, the ROD for the CALFED program has been authorized, ERP action on Sherman Island and Twitchell Island would have priority over In-Delta Storage Project future actions.

DWR and Reclamation also investigated the feasibility of mitigating for all giant garter snake habitat (if ongoing surveys establish their presence) and jurisdictional wetlands impacts on the reservoir islands through off site mitigation. The study concluded that no mitigation banks are currently available to service the entirety of Project impacts to the giant garter snake and jurisdictional wetlands. Based on current market values in the Sacramento Valley region, the cost per giant garter snake credit is $25,000 per acre, and the cost of riparian woodland is $60,000 per acre. The Sacramento District Corps will allow mitigation for emergent wetland and permanent pond to be counted toward meeting the aquatic habitat component of the giant garter snake mitigation as long as both the species needs and wetland requirements are met. Under a worst-case scenario, Project mitigation costs for jurisdictional wetlands and the giant garter snake are approximately $109 Million. Given the magnitude of compensatory habitat required to meet giant garter snake and jurisdictional wetland mitigation requirements, development of a mitigation bank specifically for the In-Delta Storage Project, or exploring mitigation options on suitable properties already owned by the Department or U.S. Bureau of Reclamation may be warranted.

The complete technical memorandum of the investigation regarding off site mitigation is included in Appendix D.

Weed Management

Invasive, non-native plants are a problem for farmers and can have a negative impact on native habitats. In many cases, once a weedy species invades a natural habitat, that native plant community is lost or severely degraded, and any wildlife relying on certain plants as integral components of that community can also become displaced (Williams 1997; Randall et al. 1998).

According to the DFA, a noxious weed is a plant that is defined as a pest by law or regulation. Pest plants are given a rating (A, B, C, D or Q) based on the importance of the pest, the ability to eradicate or control the plant successfully, and the present distribution within the state (DFA 2002).

Definitions for state ratings:

- "A" is an organism of known economic importance subject to state enforced action involving: eradication, quarantine, containment, rejection, or other holding action.
- "B" is an organism of known economic importance subject to: eradication, containment, control, or other holding action at the discretion of the individual county agricultural commissioner.
- "C" is an organism subject to no state enforced action outside of nurseries except to retard spread. At the discretion of the commissioner.
- "D" Requires no action (Parasites, predators, and organisms of little or no economic importance).
- "Q" is an organism or disorder requiring temporary "A" action pending determination of a permanent rating.

The California Exotic Pest Plant Council (CalEPPC) also maintains a list of pest plants of greatest ecological concern in California. This list focuses on non-native plants that are a serious problem in California's wild lands. The list is broken up into most invasive plants (List A), plants of lesser invasiveness (List B), and pest plants with potential to spread explosively (Red Alert) (Anderson, DiTomaso and others 1999).

The most commonly encountered invasive species found in this part of the Delta and listed by either CDFA or CalEPPC are shown in Table 5-20. Weed control efforts on the habitat and reservoir islands will be directed toward, but will not be exclusive to, these plants.

Table 5-20. Invasive terrestrial plant species known to occur in or near the project area.

Common name	Scientific name	Known on Project islands	CDFA status	CalEPPC List
Russian knapweed	*Acroptilon repens*	x	B	
Tree of heaven	*Ailanthus altissima*	x		A-2
Giant reed*	*Arundo donax*	x		A-1
Black mustard	*Brassica nigra*	x		B
Red brome	*Bromus madritensis* ssp. *rubens*	x		A-2
Italian thistle	*Carduus pycnocephalus*	x		B
Yellow star thistle	*Centaurea solstitialis*	x	C	A-1
Bull thistle	*Cirsium vulgare*	x		B
Poison hemlock	*Conium maculatum*	x		B
Pampas grass	*Cortaderia selloana*	x		A-1
Cape ivy	*Delairea odorata*			A-1
Brazilian waterweed	*Egeria densa*	x		A-2
Water hyacinth	*Eichhornia crassipes*	x		A-2
Blue gum	*Eucalyptus globulus*	x		A-1
Edible fig	*Ficus carica*	x		A-2
Fennel	*Foeniculum vulgare*	x		A-1
Hydrilla	*Hydrilla verticillata*		A	
Velvet grass	*Holcus lanatus*	x		B
Yellow water iris	*Iris pseudacorus*	x		B
Perennial pepperweed	*Lepidium latifolium*	x	B	A-1
Purple loosestrife	*Lythrum salicaria*		B	
Parrot's feather	*Myriophyllum aquaticum*	x		B
Eurasian water-milfoil	*Myriophyllum spicatum*	x		A-1
Crispate-leaved pondweed	*Potamogeton crispus*	x		B
Himalayan blackberry	*Rubus discolor*	x		A-2
Silverleaf nightshade	*Solanum elaeagnifolium*	x	B	
Medusa-head	*Taeniatherum caput-medusae*	x	C	A-1
Tamarisk	*Tamarisk spp.*	x		A-1

Management measures

The weed management program will use an adaptive management approach, as outlined by Hoshovsky and Randall (2000). The adaptive management approach includes:

- Establish management goals and objectives for each site.
- Determine which weed species may hinder the attainment of the goals.
- Determine which methods are available for control of the species.
- Design and implement a management plan designed to move conditions towards management goals and objectives.

- ∉ Monitor and assess the impacts of management actions in terms of effectiveness in moving towards goals and objectives.
- ∉ Reevaluate, modify if necessary, and start the cycle again.

The goals and objectives of habitat management will be specific to each island, but control of weed populations will depend on three main strategies:

1. Prevention and early detection of new infestations
2. Physical and chemical control measures
3. Biological control measures

Preventing new infestation

Prevention of a weed infestation is the most effective method of control. This strategy must incorporate education about the weed, how it spreads and its impact to the area. It is necessary for workers to understand the appropriate weed abatement measures and cleanup for different weed species (some plants can propagate from a root cutting or just a small piece of the plant). All agencies and personnel working on the islands must be aware of the weeds of concern and the procedures used to prevent infestations.

Some of the main precautionary measures that can be taken to prevent weed infestation or spreading of a new infestation include: removing seed sources from roads, trails and other dispersal routes; planning construction projects to minimize soil disturbance and reestablish vegetation as soon as possible; making sure that fill dirt, mulch, seed mixes or other materials imported to the site are weed-free; washing vehicles and equipment to remove weed seeds and other propagules before moving them to another area; and follow-up monitoring of work sites to detect new weed populations while they are still small and easily controlled (Hoshovsky and Randall 2000).

Early detection of new infestations

Early detection of new infestations of weeds is an important tool. If detected early enough, a weedy species can be eradicated before it spreads and becomes a larger problem. With early detection some simple methods such as manually pulling or mowing can be used for eradication, versus repeated use of herbicide treatments, which is a more expensive weed abatement method. Periodic monitoring of the islands by a qualified botanist will aid in detecting new weed infestations.

Physical and chemical control measures

There are several measures that may be used to control weeds; effectiveness of each method should be evaluated on a species level and site-specifically.

Hand pulling/ hand weeding: Hand weeding is a good method when dealing with small infestations of plants or infestations that occur in sensitive habitat areas. This method is best used on plants with a tap root (knapweed, pepperweed) and some young plants. One downside of this method is that it is very time consuming and can be costly.

Pros: Non-toxic, selective process suitable for native habitat areas.

Cons: Time consuming, costly and labor intensive; can result in bare ground where other non-natives can invade; possible trampling of non-target species.

Mowing and disking: Mowing or disking work well to reduce weed populations when done at the right time of the year (before seed production). These methods can be used in conjunction with other methods like herbicides or burning.

Pros: Non-toxic, reduces seed production. Disking is cost effective and most appropriate when used in agricultural settings.

Cons: Mowing doesn't kill weeds, it just suppresses them; both methods are non-specific; soil disturbance can open up sites to other weed infestations.

Burning or Flaming. Prescribed burns can be effective in reducing weeds, especially in native plant communities that evolved with fire. This method may help in the suppression of yellow star thistle by burning before the plant produces viable seed (June-July). Flaming selected weeds and heat-girdling stems of brushy species using a blowtorch or flamethrower is less costly than selective herbicide treatment and is effective in wet weather.

Pros: Can improve efficiency of herbicide treatment by removing old plant materials and litter, allowing more herbicide to reach the living tissues of the weeds.

Cons: Causes air pollution; hard to get fire hot enough to kill seeds; some natives are not fire-tolerant; burn permits can be difficult to obtain; fire escape is a risk; erosion can be a problem on denuded soils.

Flooding. Flooding can be an effective method of weed control. Many plant species cannot withstand periods of prolonged flooding (*Lepidium*). This method works by preventing oxygen from getting to the roots of the plant.

Pros: Non-toxic, cheap method if water is available.

Cons: Does not impact weed seeds; some seeds can remain viable for 2 years after flooding. Flooding may spread weed seeds and plant parts further into an area.

Herbicides. Herbicides should only be applied by a licensed pesticide applicator. Spot treatment with herbicides is preferable over broadcast spraying. When herbicides are used, signs should be placed in areas to notify visitors and personnel of the potential harm and should state when re-entry to those areas is allowed.

Pros: Can cover a larger area of weed infestation; maintain a longer time period in between treatments; causes minimal ground disturbance.

Cons: Toxic; requires a trained and qualified applicator and reporting of use; may impact non-target plant species; some chemicals cannot be used in or near water; chemicals may persist and contaminate the environment; can be expensive.

Biological control measures

Biological control involves the use of animals, fungi or other microbes that prey upon, consume, or parasitize a target species (Bossard and others 2000). At this time, no specific biocontrol agents have been identified for most of the weed species of concern in the project area, except for purple loosestrife. There are two leaf-eating beetles (*Galerucella spp.*), a root-mining weevil (*Hylobuius transversovittatus*), and a seed-eating beetle (*Nanophyes marmoratus*) permitted for release in California to control loosestrife; however low loosestrife density in the Delta may not be able to sustain insect populations (SFEI 2003).

Managed grazing. Grazing by cattle, goats, or sheep can be an important tool in weed management. Intensive grazing can be timed to coincide with a particular stage in the weed life cycle that is most vulnerable to predation.

Pros: If properly managed, grazing is minimally disruptive to native habitats, and does not require a large investment of time or funding.

Cons: Grazing must be continued until the weed’s seedbank is exhausted. Some weeds may be spread by the droppings of grazing animals.

Competition and restoration. Restoration of native habitats by seeding and/or planting natives provides competition for the weeds. Seed or other propagules should be collected from on site or nearby to increase chances of successful restoration.

Pros: Increases habitat values and provides a long-term solution to weed problems.

Cons: Expensive method, requiring lots of input and management especially in the first few years. Potential introduction of poorly adapted genotypes or loss of genetic diversity if propagules are not available locally.

Weed species of concern and potential control measures

Of the 28 weed species listed in Table X-1, only 6 represent a substantial threat to native terrestrial plant communities of concern on the project islands (marshes and other wetlands, riparian areas). These are giant reed, pampas grass, cape ivy, perennial pepperweed, purple loosestrife, and Himalayan blackberry. Other species are primarily invaders of disturbed sites and can be managed using standard agricultural weed control measures. Aquatic weeds such as Brazilian waterweed and water hyacinth are a management concern in ponds, ditches, and canals on the habitat islands and on the reservoir islands; waterways adjacent to the islands fall under the management of the Department of Boating and Waterways, which maintains control programs for these species.

Giant reed (*Arundo donax*)

Giant reed is the largest member of the grass family (Poaceae). It is a perennial plant that reaches from 9 to 30 feet tall, often growing in clumps reaching hundreds of feet across. Leaves are in 2 rows along the stem, and the hollow stems are about 1-½ inches in diameter. A large flower head (panicle) extends 1 to 2 feet from the top of the stem (Hickman 1993); however, the species has not been observed to set viable seed in California. This plant primarily reproduces by rhizomes but pieces of the stem may also regenerate. Plants have been observed to grow 4 inches per day, one of the fastest rates known for terrestrial plants.

Because of its aggressive growth, *Arundo* can choke out other native plants and may actually block stream channels and cause flooding and erosion. It is also a fire hazard, since the tall stems become brittle and burn quickly. While fire will burn the aboveground parts of the plant, the underground matted roots (rhizomes) survive fire and regenerate quickly (Dudley 2002).

Possible Control Methods

Plants that are less than 6 feet tall can be removed by hand. Since this plant can regenerate from small pieces of stem or root material, the entire plant should be removed from the site and disposed of properly. This method allows for selective removal and very little disturbance to surrounding vegetation (Dudley 2000).

Larger plants are trimmed back to the base, then treated with the proper herbicide (one containing glyphosate as the active ingredient). The herbicide can be painted directly onto the remaining portions of the plant. This procedure may need to be repeated until the plant dies.

Rodeo® and Roundup® (both have glyphosate as the active ingredient) are registered for use in California on *Arundo*. Rodeo® can be used in wetlands; Roundup® can only be used away from water in the upland areas. Herbicide is most effective when applied to plants after flowering and before they go dormant, usually from August to early November (Dudley 2000).

For control of plants in wetlands, a 50- 75% solution of Rodeo® can be applied to stems cut within 2 to 4 inches of the substrate. The concentrate can be applied with a sponge, and it may be advantageous to add a dye to the concentrate so it can be seen. Follow-up of this method should occur once a month over a period of 6 months (Dudley 2000).

Water hyacinth (*Eichhornia crassipes*)

Water hyacinth is a generally free-floating perennial member of the Pontederiaceae (Pickerel-weed) family. The leaves are bright green and waxy and the flower is lilac, pale blue or white with yellow stripes on the petals. Plants can multiply and spread vegetatively, by the roots, and by seeds, which can remain viable for up to 20 years (Batcher 2001). This plant forms dense mats on the water surface. It can be found in natural and man-made fresh water systems.

Plants can quickly dominate a waterway, degrading habitat for waterfowl, impeding drainage, obstructing navigation, fouling water pumps and blocking irrigation channels (Godfrey 2000). Reduction in water flow can cause flooding which can damage canal and levee banks; areas with decreased flows can also be ideal breeding sites for mosquitoes and other vectors (Godfrey 2000; Batcher 2001).

Possible Control Methods

Small infestations can be harvested, removed and left to dry on the banks. With this method all plant material needs to be removed or it will re-infest the area (Godfrey 2000). This method is labor-intensive and expensive. Floating barriers can be placed in an area to contain the weeds and then they can de dredged out and left to die on the banks.

Chemical sprays have been used, but all products need to be registered for use in the aquatic environment. The California Department of Pesticide Regulations retains a list of those products registered for use in California for different ecosystems. Directions on the product label should always be followed when applying a pesticide. Glyphosate (Rodeo ®) has been used as a foliar spray, and an application of 2 kg/ha kills the plants (Godfrey 2000; Batcher 2001). This active ingredient is non-toxic to fish, but slightly toxic to aquatic invertebrates. Copper sulfate has also been used as a spray.

Perennial pepperweed (*Lepidium latifolium*)

Perennial pepperweed is a member of the mustard family (Brassicaceae) that can grow over 6 feet high, (typically 3 to 4 feet), with smooth, green-grayish leaves, dense aggregations of tiny (< 1/4 in.) white flowers, and horizontal underground stems (rhizome) that can be viewed by uprooting a plant. The species is native to Eurasia, and arrived on the East Coast of the United States about 1924. By 1941 the plant was present in Solano County, and in subsequent years has spread to large areas of the South Delta, and to limited areas of the Central Bay (May 1995).

Perennial pepperweed spreads through dispersal of seeds and rhizome fragments, and can establish dense colonies in a variety of environments including marshes, meadows, saline soils, riparian areas, beaches, and disturbed areas such as roadsides, agricultural fields and irrigation channels. These dense colonies displace native plant species and dense linear patches along sloughs and levees can exclude all other vegetation.

Possible control methods

Chemical control appears to be the most effective means of controlling perennial pepperweed. Mechanical methods such as disking do not alone provide control because plants can rapidly resprout from fragments left in soil (Young et al. 1995). Prescribed burning is not an effective method of control alone, because typical infestations may not be able to maintain burning (Howald 2000). Flooding may be effective if an area can be flooded for a prolonged period of time (May 1995). Biological control agents are not available at this time, and are unlikely to be developed to associated risks posed to commercial crop plants in the mustard family (Brassicaceae) and native Lepidium species (Young et al. 1995).

Application of the herbicides chlorsulfuron, triclopyr (as Garlon3A® and Garlon4®), and glyphosate (as Rodeo® and Roundup®) have been shown to be effective in controlling perennial pepperweed in studies at Grizzly Island Wildlife Area in Suisun Marsh (Howald 2000). Estimated costs for materials and application by a contractor are estimated at approximately $250 per acre for glyphosate, depending on size of treatment area, scale of treatment, and herbicide dosage (Gibbons et al. 1999).

Cape ivy (*Delairea odorata = Senecio mikanioides*)

Cape ivy, a native of South Africa in the Asteraceae family, is a climbing vine with small inconspicuous yellow flowers, leaves and stems smooth, shiny, hairless, plentiful, bright green; leaves 1 to 4 in. long, evenly spaced on stem, with 5 to 9 lobes each. Cape ivy is easily confused with native wild cucumber (*Marah fabaceus*), which has less shiny leaves, ribbed vs. smooth stems, many spiraling tendrils and distinctive round 1 in. diameter fruits that are covered in spines. It was introduced to California in the 1950's as an ornamental and has spread to many coastal regions in the state (Bossard 2000).

Cape ivy grows well in shady and damp places and on disturbed ground. Cape ivy spreads by sending out runners that root and create new plants; fragments of runners or roots can resprout and establish new plants as well. Fragments of stolons were found to root after 10 weeks of drying in the sun. It is highly invasive, spreads quickly, and is capable of blanketing and smothering native vegetation, including trees (Bossard 2000).

Possible control methods

Manual or mechanical removal of stems and roots, using pointed or pronged rakes, is an effective control method when followed by removal of plant material to prevent resprouting of plant fragments. Follow-up monitoring and treatment, to remove resprouts, is required for effective control. This method involves a high likelihood of disturbance to non-target plant species because Cape ivy tends to grow in dense mats close to the ground (Bossard 2000).

Herbicide has been used effectively to control Cape ivy, as a mixture of 0.5% glyphosate, 0.5% triclopyr, and 0.1% silicone surfactant applied as a foliar spray. The optimal time for application is in late spring, after the flowering stage has ended (Bossard and Benefield 1995). Costs for materials and application by a contractor are approximately $250 per acre for glyphosate, depending on size of treatment area, scale of treatment, and dosage (Gibbons *et al.* 1999).

Prescribed burning has not been extensively studied as a control method because the foliage has a high moisture content. No biological control agents are currently available for release in California (Bossard 2000), but tests on potential control agents are underway by the USDA Agricultural Research Service (USDA-ARS) (Balciunas 2003).

Pampas grass (*Cortaderia jubata*)

Pampas grass is a large, dioecious tussock grass that is native to the Andes Mountains of northern Argentina, Bolivia, Peru, and Ecuador at elevations of 2800 to 3400 m, where it can form nearly solid stands of several hundred hectares (Costas Lippmann 1977). Pampas grass can be recognized by its distinctive huge nodding pinkish or purplish flower plumes (later turning creamy white), and dark green 1-cm-wide drooping leaves with razor-like margins. Flower stems often rise up to 3 times higher than the clump of foliage. Pampas grass flourishes mostly in coastal areas and probably needs at least some summer moisture from fogs and freedom from freezing temperatures. Several consecutive nights of frost will generally not kill the plant, but can severely damage it (Costas Lippmann 1977).

The chief reason for the success of pampas grass as an invader is its prolific production of seeds, which are abundantly produced annually, and which rapidly establish on bare soil. Seeds establish most readily in wet sandy soil without existing vegetation, but have broad habitat requirements and will grow vigorously in nearly any soil, under low or high moisture regimes, in full sun or dense shade (Cowan 1976). Pampas grass seedlings rapidly grow and accumulate above- and belowground biomass once they are established, making them highly competitive with native plants. Even at low densities pampas grass can out compete other species because of the amount of cover it can occupy; even a few plants can have a large potential impact because it is a perennial plant, produces seed annually, and the seeds are light and wind-dispersed.

Possible control methods

Every effort to control pampas grass should be made before it becomes well established. Adequate control of pampas grass can be achieved with mechanical or chemical methods or both. Physical removal is effective, and minimizes impact on the native plant community, if there are low densities of the weed or if the individual plants are quite small. Seedlings or small plants can be pulled or dug out, and large plants can be dug out with a pick and shovel. The entire root crown must be removed to avoid subsequent sprouting, although it is not necessary to dig up all the lateral roots (Cowan 1976). Plumes should be cut off plants that cannot be removed immediately to reduce dispersal of seeds.

In areas with high plant densities or with well-established plants, pampas grass is best controlled with chemical treatments. Aminotriazol and dalapon have been used to control pampas grass (Anonymous 1976), although no guidelines are available on concentrations. Roundup can be used successfully to kill both seedlings and large plants of pampas grass (DiTomaso 2000), where it should be sprayed on the plants early in the morning at concentrations recommended by the manufacturer, taking care to avoid spraying it on nontarget plants. Even if herbicides are successful in killing the plant, a large amount of dead biomass remains on the surface to prevent access by native vegetation.

Purple loosestrife (*Lythrum salicaria*)

Purple loosestrife is an erect perennial with showy pinkish-purple flower spikes that is native to Eurasia. Mature plants can grow 2 - 3 m tall, and develop into a large clump up to 1.5 m in diameter. Above ground foliage usually dies during the cool season, and new shoots sprout from a broad woody crown in spring. Originally cultivated as an ornamental and medicinal herb, purple loosestrife has escaped cultivation and become a noxious weed of wetlands in many regions throughout temperate North America, often forming dense colonies that displace native vegetation and wildlife (Benefield 2000).

Plants reproduce primarily by seed, although stem fragments can develop roots under favorable conditions. A large plant can produce more than 2 million viable seeds in one season, which disperse with water, mud, human activities, and by clinging to feathers, fur, and feet of animals. Seeds typically germinate mid-spring through early summer, producing seedlings that can mature and flower within 8-10 weeks.

Possible control methods

Mechanical control is effective mainly for small infestations, and includes mowing or cutting, pulling, and digging. While mowing is generally ineffective, mowing timed at the bud stage may reduce seed production. Timing is critical, because mowing at earlier stages may increase stem densities, and mowing after seed production only serves to spread the infestation. Mowing is frequently not even an option in most wetland areas, drainages, or along watercourses. Hand pulling or digging results in more disturbance, but may be successful on small infestations. Young plants are easily pulled, but older plants may require extensive digging. New plants may emerge from missed roots or from stems left lying in contact with moist soil.

Biological control is probably the most viable option for long-term control of large purple loosestrife infestations. At least four insects are being tested in California, but none are currently available for release. Two species of leaf-eating beetles (black-margined and golden loosestrife beetles) have had considerable success in reducing purple loosestrife in other states and may be promising here in California.

Chemical control can be used effectively on large infestations. Spot applications of glyphosate at 1.5% v/v timed at the early flowering stage have been effective, and fall applications are recommended. Glyphosate can be successfully integrated with mowing and applied directly to the tops of cut stems in a 20-30% solution with a wick applicator. It is important when using herbicide to avoid injury to desirable vegetation because purple loosestrife is highly competitive and will rapidly reinfest open areas. It may not be necessary to wet all of the foliage completely to kill the plant, but wetting at least 25% of the foliage is recommended.

Himalayan blackberry (*Rubus discolor*)

Himalayan blackberry, a plant in the rose family (Rosaceae), grows as a dense thicket of long, bending branches (canes), appearing as tall, ten-foot mounds or banks, particularly along watercourses. Leaves have five leaflets, and canes have stout hooked prickles; in contrast, native blackberries have three leaflets and much thinner prickles. Flowers are white, yielding black berries that usually ripen later than native blackberries. Flowering begins in May and continues through July. Fruit is produced from July to September. Most blackberries produce good seed crops nearly every year. Immature fruit of Himalayan blackberry is red and hard, but at maturity fruit becomes shiny black, soft, and succulent.

Despite its name, Himalayan blackberry is native to western Europe (Hickman 1993). It was probably introduced to North America in 1885 as a cultivated crop and by 1945 it had become naturalized along the West Coast and also occurred in nursery and experimental grounds along the East Coast and in Ohio (Bailey 1945). Himalayan blackberry occurs in California along the coast in the Coast Ranges, Central Valley, and the Sierra Nevada (Dudley and Collins 1995), forming impenetrable thickets in wastelands, pastures, and forest plantations, roadsides, creek gullies, river flats, fence lines, and right-of-way corridors (Parsons and Amor 1968). It is common in riparian areas, where it establishes and persists despite periodic inundation by fresh or brackish water.

It seeds heavily, and seeds are readily dispersed by mammals and birds. Seeds can be spread considerable distances by streams and rivers (Parsons 1992). It also spreads vegetatively by rooting of cane tips. Periodic flooding can produce conditions conducive to the growth and spread of blackberries. Himalayan blackberry is one of few woody plants that pioneer certain intertidal zones of the lower Sacramento River (Katibah *et al*. 1984). Himalayan blackberry tolerates a wide range of soil pH and texture but does require adequate soil moisture, and seems to prefer disturbed and wet sites even in relatively wet climates.

Possible control methods

Mechanical removal or burning may be the most effective ways of removing mature plants. Most mechanical control techniques, such as cutting or using a weed wrench, are suitable for Himalayan blackberry. Care should be taken to prevent vegetative reproduction from cuttings. Burning slash piles is an effective method of disposal. Treatment with herbicides should be considered cautiously for two reasons: Himalayan blackberry often grows in riparian areas, where the herbicide may be distributed to unforeseen locations by running water, and some herbicides promote vegetative growth from lateral roots.

Reestablishment of Himalayan blackberry may be prevented by planting fast-growing shrubs or trees, since the species is usually intolerant of shade. Regrowth has also been controlled by grazing sheep and goats in areas where mature plants have been removed.

Brazilian waterweed (*Egeria densa*)

Brazilian waterweed (*Egeria densa*) is a perennial freshwater aquatic herb in the Hydrocharitaceae family, native to Argentina, Brazil, and Uruguay. It has stems up to fifteen feet long that are frequently branched, which are covered with whorls of small green leaves. It is distinguished from related species by the absence of turions (shoots from underground stems) and tubers and by the presence of showy, white flowers that float on or just above the water. It is usually rooted in bottom mud, but may be found as a free-floating mat or fragments with its buoyant stems near the surface. Brazilian waterweed occurs in cool to warm freshwater ponds, lakes, reservoirs, and slowly flowing streams and sloughs. It can root up to seven meters below the water surface (Parsons 1992). In California, Brazilian waterweed occurs at less than 7,000 feet elevation in the Sierra Nevada, Central Valley, San Francisco Bay, and San Jacinto Mountains (Hickman 1993).

The timing and location of Brazilian waterweed's entry into California are unknown, but human dispersal via the aquarium trade is the most common means of dispersal (Parsons 1992). Once naturalized, Brazilian waterweed can spread along existing water courses into suitable new habitats without further human activity. Stem fragments at least two nodes long frequently break off and float away from the parent plant during active growth in spring (Parsons 1992). Fragments occur during all times of the year because of mechanical shearing of water flow, wave action, waterfowl activity, and boating.

Brazilian waterweed's dense growth significantly retards water flow, interfering with irrigation projects, hydroelectric utilities, and urban water supplies. It may also slow water traffic and interfere with recreational and commercial activities such as boating, swimming, and fishing. Brazilian waterweed reduces the abundance and diversity of native plants in lake bottoms, and this is probably accentuated by increased sediment accumulation beneath the weed beds (deWinton and Clayton 1996).

In California (and North America in general) reproduction and dispersal are via fragments of shoots and rhizomes, since only the male plant has become established. No seed formation has been documented (Anderson 1996, 1998). Stem fragments can take root in bottom mud or may remain as free-floating mats. Growth is most rapid during summer, as day length and temperature increase. Biomass in lakes reaches a maximum during late summer and fall. Thick mats form, consisting of long, intertwining, multi-branched stems below the water surface. No information is available on the rate of individual plant growth (Parsons 1992).

Possible control methods

Several methods are useful in removing Brazilian waterweed, particularly where water movement is minimal. Manual/mechanical methods such as pulling, cutting, and digging with machines are costly, provide only temporary relief, and encourage spread of the plant by fragmentation (mechanical harvesting produces thousands of viable fragments per acre (Anderson 1998). Biological control of Brazilian waterweed has been accomplished with introductions of two fish species into water bodies (Avault 1965): the white amur or Chinese grass carp (*Ctenopharyngodon idella*) and the Congo tilapia (*Tilapia melanopleura*). Currently, only the sterile (triploid) grass carp can be used in California and only in six southern California counties (Imperial, San Diego, Riverside, San Bernardino, Los Angeles, and Ventura). Permitted uses are authorized by the California Department of Fish and Game throughout the state with certain restrictions.

At present the following herbicides can be used at label concentrations to control Brazilian waterweed in California: diquat (contact type); copper-containing products (contact type); acrolein (contact type and highly restricted uses where no fisheries are impacted); and fluridone (systemic type requiring 4 to 6 weeks of treatment at very low rates) (Anderson 1996). However, herbicides in aquatic systems must be handled carefully to avoid worsening the situation - a specialist in control of aquatic weeds should be consulted before using.

Mitigation Cost Estimates

The preliminary cost estimates for the revised HMP are based on limited site information, limited planting specifications, and no engineering information (Table 5-21). Once the revised HMP is agreed upon by the resources agencies, engineering and construction requirements will be determined and more specific cost estimates for site construction, habitat development and operation and maintenance can be developed. Site construction and earthwork estimates are based upon the modified quantities provided by DW Properties. The unit cost was based upon the 2000 In-Delta Storage investigation Pre-Feasibility Study Draft Report (CALFED 2000b). The cost for conservation easements is based on the cost other agencies have paid for similar easements.

Table 5-21. Preliminary cost estimates for habitat development in the Revised HMP[a]

Activity	Estimated Cost
Purchase conservation easements (3,900 acres)	$ 4,680,000
Site construction (earthwork)[b]	$ 19,913,492
Vegetation installation[c]	$ 3,577,161
Subtotal	$ 23,490,653
Contingencies (20%)	$ 4,698,131
Contract subtotal	$ 28,188,784
Total Cost	$ 32,868,784

[a] Estimates are based on limited site information, limited planting specifications, and no engineering information.
[b] Site construction and earthwork estimates are based upon quantities provided by Delta Wetlands Properties. Unit cost was based upon the 2001 In-Delta Storage Program Draft Report on Engineering Investigations.
[c] Habitat vegetation cost estimates were based on the information in Table 5-21.
Note: Cost of borrow pond development, and pumps, siphons, & culverts associated with the habitat management plan are not included. Mitigation costs for levee improvements on the reservoir islands are not included. Land acquisition costs are not included.

Vegetation installation cost estimates were based on cost from similar projects in the region (i.e. Prospect Island, Decker Island, Stone Lakes, Cosumnes River Preserve, Hill Slough), current catalogs from plant nurseries, published information (EPA 1999) and adjusted for specific habitat development requirements (Tables 5-22 and 5-23). The cost estimates for developing crops were based upon UC Davis studies (Kearny and others 1994, 2000, Vargas et al 1998).

Table 5-22. Preliminary cost estimates for vegetation installation[a]

Develop Habitats	Total Acres	Estimated cost/acre	Estimated Cost
Corn	445	$ 69	$ 30,705
Wheat	1820	$ 25	$ 45,500
Alfalfa hay	2860	$ 87	$ 248,820
Other crops (harvested)[b]	540	$ 0	$ 0
Emergent marsh (min 30% cover after 3 years)	(276)921	$ 500	$ 138,000
Riparian (>350 seedling/acre after 3 years)	527	$ 5000	$ 2,635,000
Herbaceous upland (assume 25% native grass seed)	1488	$ 322	$ 479,136
Total			$ 3,577,161

[a] Estimates (adjusted for 2001 dollars) are based on costs from similar projects in the region (i.e. Prospect Island, Decker Island, Stone Lakes, Cosumnes River Preserve, Hill Slough), current catalogs from plant nurseries, EPA (1999), Kearny and others (1994 and 2000), Vargas et al (1998) and adjusted for the specific habitat development requirements.
[b] It is assumed that the income from selling these crops will cover the cost of installation and maintenance.

Table 5-23 provides an estimate of the on-going costs of mitigation and monitoring required for the project. Cost for the purchase and installation of pumps, siphons, and culverts were not included in this estimate. Annual average operations cost are based upon staff and equipment requirements for similar projects in the region. This includes costs for weed control. DWR staffing costs were used to determine these figures. This includes one full time habitat manager and 2 full time maintenance staff. The estimate does not include the cost of land acquisition or for the purchase of equipment. The monitoring plan development and implementation of the monitoring are based upon DWR staff time cost.

Table 5-23. Estimated ongoing costs for mitigation and monitoring for the revised Habitat Management Plan for the life of the project

Description	Unit	Cost (dollars)
Wildlife/habitat monitoring	Salary/year	121,500[a]
DFG monitoring support fund	Salary/year	80,000[b]
Airstrip operations monitoring	Salary/year	30,500[c]
Monitoring subtotal		202,000
Annual O&M cost for Habitat Islands	Salary & materials	1,000,000[d] - 1,400,000
Total ongoing annual cost		1,202,000 – 1,602,000

[a] DWR ES III salary (benefits & overhead) for 100% of the year (includes monitoring for listed and sensitive species, habitat requirements, 404 permit requirements, & conservation easements)
[b] Current August 2001 cost based on $75,000 per year, January 1998 dollars adjusted for inflation.
[c] DWR ES III salary (benefits & overhead) for 25% of the year
[d] Cost estimate includes salary for DWR Habitat Manager, 2 maintenance staff, and annual cost for habitat management.
Note: All costs are based on August 2001 dollars.

The preliminary cost estimates for implementing the habitat requirements in the revised HMP is approximately $33 million. This includes conservation easements for Swainson's hawks, earthwork, vegetation installation, contingencies and engineering, legal and administrative costs. Annual costs are estimated to be approximately $1.6 million. This includes implementing terrestrial monitoring requirements and the annual operations and maintenance costs. Total one time mitigation monitoring costs would be approximately $400,000 (DWR 2002).